RCRA FACILITY INVESTIGATION REPORT
NAVAL SUPPORT ACTIVITY MID-SOUTH

AREA OF CONCERN A
NORTHSIDE FLUVIAL GROUNDWATER

VOLUME II OF II

Revision: 02

CTO-094

Prepared for:

Department of the Navy
Southern Division
Naval Facilities Engineering Command
North Charleston, South Carolina

Prepared by:

EnSafe Inc.
5724 Summer Trees Drive
Memphis, Tennessee 38134
(901) 372-7962

February 17, 2000

Appendix A

Summary of Fluvial Deposits Groundwater Data on Northside

A.0 SUMMARY OF FLUVIAL DEPOSITS GROUNDWATER DATA ON NORTHSIDE

A map of the 12 SWMUs that make up the Northside AOC (SWMUs 1, 3, 5, 7, 8, 10, 15, 21, 27, 40, 60, and 62, North Fuel Farm, and Background location 5) is provided in Figure A-1. Data from all of these SWMUs, except for the SWMU 7/Apron Area, have been presented in earlier submitted RFI or CSI reports which have been either approved by the USEPA and TDEC or are pending approval. Because this information has been presented in earlier submittals, only a cursory overview of these SWMUs, the findings of their investigations, and the status of each investigation are presented in this appendix. Additional information not provided in the text (sampling rationale, shallow soil and loess groundwater data, historical information, etc.), can be found in the sources cited in the appendix.

The groundwater data from theses SWMUs are compared to USEPA RBCs and MCLs. The MCLs are the established ARARs for public water systems and the enforceable standard that will be targeted during the CMS. The 12 Northside SWMUs with fluvial deposits groundwater data have been divided into six areas (Areas A through F in Figure A-1). The SWMUs in each area, the potential risk posed by groundwater, and their status are summarized below. Section A.1 discusses the cumulative RBC exceedances, explained below further, associated with each Northside SWMU. Section A.2 discusses those SWMUs that have been recommended for a CMS as a result of contaminants identified in groundwater in excess of the MCLs.

The summary tables (A-1 through A-6) provided at the end of the appendix correspond with the groundwater data collected from the fluvial deposits from Areas A through F shown in Figure A-1. They include groundwater data collected from monitoring wells during the initial and confirmatory sampling events and long-term monitoring events 1, 2 and 3. Fluvial deposits groundwater data collected through direct push technology (DPT) methods are also included in the summary tables. Data collected from subsequent long-term monitoring events 4 and 5 are not included in this appendix as this data was collected while the draft of this report was in preparation. This data can be found in the *Assembly A Long-Term Groundwater Monitoring Report, Addendum, Event 4* (EnSafe, January 26, 1998) and *Event 5* (EnSafe, March 20, 1998).

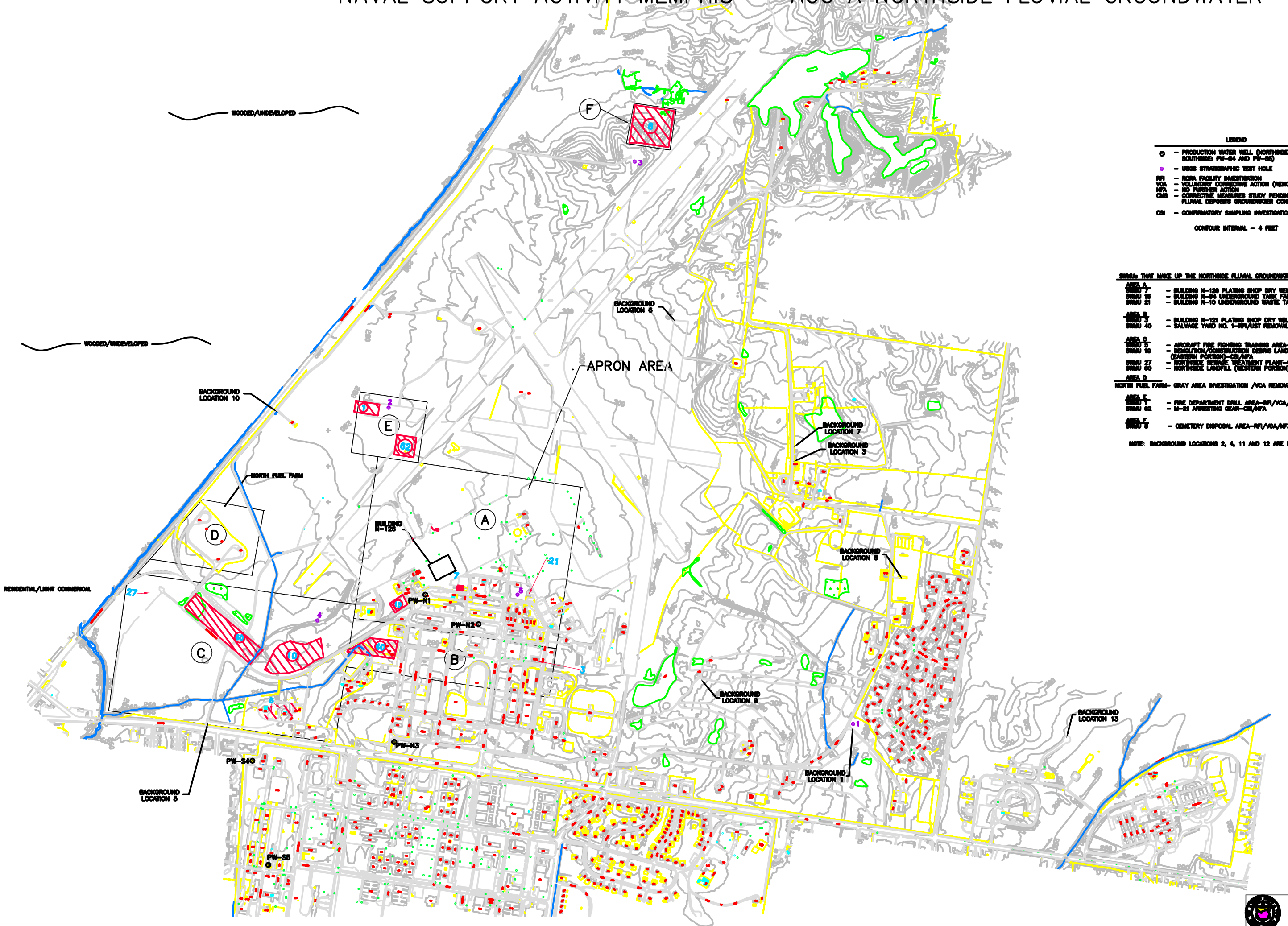
A.1 Risk Posed by Fluvial Deposits Groundwater

Groundwater samples have been collected from the fluvial deposits using either DPT methods or monitoring wells. Monitoring wells at Northside SWMUs have been sampled numerous times with analytes and methods varying between sampling events. The data set is cumbersome thus illustrating the groundwater risk for each sampling event would overburden the reader with data. Therefore, the cumulative RBC exceedance or "R factor" has been determined at each fluvial deposits monitoring well over all of the sampling events. This factor represents the sum of the maximum concentrations detected during monitoring, divided by the respective RBCs for the compounds. For example, the R factor for a groundwater sample containing 10 μg/L carbon tetrachloride and 20 μg/L of trichloroethylene is 75 — calculated as:

10 μg/L $\div$ 0.16 μg/L (RBC for carbon tetrachloride) + 20 μg/L $\div$ 1.6 μg/L (RBC for TCE) = 62.5 + 12.5 = 75.

Possible synergistic effects associated with multiple contaminants are not considered; however, the R factor is very conservative, particularly at sites containing monitoring wells and multiple sampling events, because it represents the maximum detections over all sampling events. The R factor for carbon tetrachloride during the first sampling event may be summed with the R factor for TCE during the third sampling event. The contaminants detected during monitoring at each well and the range and mean of the contaminant concentrations are provided in Tables A-1 through A-6. VOCs detected through DPT investigations are also included in the tables and weighed equally because, like data collected from monitoring wells, these samples were analyzed by a offsite laboratory using USEPA Method 8240 or an onsite laboratory using USEPA Method 8021.

NAVAL SUPPORT ACTIVITY MEMPHIS – AOC A NORTHSIDE FLUVIAL GROUNDWATER



LEGEND

- ⊙ – PRODUCTION WATER WELL (NORTHSIDE: PW-N1 THROUGH PW-N3, SOUTHSIDE: PW-S4 AND PW-S5)
- ● – USGS STRATIGRAPHIC TEST HOLE

RFI – RCRA FACILITY INVESTIGATION
VCA – VOLUNTARY CORRECTIVE ACTION (REMOVAL)
NFA – NO FURTHER ACTION
CMS – CORRECTIVE MEASURES STUDY PENDING FOR FLUVIAL DEPOSITS GROUNDWATER CONTAMINATION

CSI – CONFIRMATORY SAMPLING INVESTIGATION

CONTOUR INTERVAL – 4 FEET

SWMUs THAT MAKE UP THE NORTHSIDE FLUVIAL GROUNDWATER AOC A

AREA A
SWMU 7 – BUILDING N-126 PLATING SHOP DRY WELL– RFI/VCA/CMS
SWMU 15 – BUILDING N-94 UNDERGROUND TANK FARM– CSI/RFI/CMS
SWMU 21 – BUILDING N-10 UNDERGROUND WASTE TANK–RFI/CMS

AREA B
SWMU 3 – BUILDING N-121 PLATING SHOP DRY WELL–RFI/VCA/NFA
SWMU 40 – SALVAGE YARD NO. 1–RFI/UST REMOVAL/NFA

AREA C
SWMU 5 – AIRCRAFT FIRE FIGHTING TRAINING AREA–RFI/VCA REMOVAL PENDING/CMS
SWMU 10 – DEMOLITION/CONSTRUCTION DEBRIS LANDFILL (EASTERN PORTION)–CSI/NFA
SWMU 27 – NORTHSIDE SEWAGE TREATMENT PLANT–CSI/NFA
SWMU 60 – NORTHSIDE LANDFILL (WESTERN PORTION)–RFI/VCA REMOVAL/NFA

AREA D
NORTH FUEL FARM– GRAY AREA INVESTIGATION /VCA REMOVAL/NFA

AREA E
SWMU 1 – FIRE DEPARTMENT DRILL AREA–RFI/VCA/NFA
SWMU 62 – M-21 ARRESTING GEAR–CSI/NFA

AREA F
SWMU 6 – CEMETERY DISPOSAL AREA–RFI/VCA/NFA

NOTE: BACKGROUND LOCATIONS 2, 4, 11 AND 12 ARE LOCATED ON THE SOUTHSIDE

500 0 500
SCALE FEET

RCRA FACILITY INVESTIGATION
NAVAL SUPPORT ACTIVITY MID-SOUTH
MILLINGTON, TN

FIGURE A-1
NORTHSIDE BASEMAP
AND SWMUs WITHIN AREA OF CONCERN A

Dr by: K. BRONSON	Tr by: NAME	
Ck by: NAME	App by: NAME	Sheet 1
Date: 01/17/00	DWG Name: 04NBSWAS	Of 1

This page intentionally left blank.

Consistent with previous NSA Mid-South submittals, inorganics in groundwater are not discussed unless the contaminants exceed both the RBC and two-times-the-mean background reference concentrations (RC; discussed further in Section 4). The R factors for the inorganics in the tables were calculated by dividing the contaminant concentration by the RBC only at locations where the detected value exceeded the RBC.

The R factor associated with each well and DPT location has been scaled with varying symbol sizes in the figures supporting the discussion below. Because of the numerous wells, DPT locations, and contaminants detected at Area A (Apron Area), contaminants responsible for the RBC exceedances have not been included with the symbols for the Apron Area (Figures A-2 through A-4). See Table A-1 for this list. Contaminants exceeding RBCs in the remaining areas (Areas B through F) are shown on the figures, along with the frequency of their detection (for wells only).

A.1.1 Area A — The Apron Area (SWMUs 7, 15, and 21)

The Apron Area is the largest and most extensively investigated area on the Northside; however, this discussion of the SWMU 7 (Apron Area) investigation is limited to a summary of the analytical results, which are detailed in the previous discussion of the nature and extent (Section 4). Because the SWMU 7 investigation overlapped with investigations of neighboring SWMUs 15 and 21, data collected from the three SWMUs are presented together in Figures A-2, A-3, and A-4, which illustrate the RBC exceedances associated with groundwater contaminants in the upper, middle, and lower (basal) parts of the fluvial deposits.

- *Building N-126 Plating Shop Dry Well (SWMU 7)/Apron Area*

The RFI focused on the Building N-126 dry well and expanded to include most of the apron area as described in Section 3. At the end of the SWMU 7/Apron Area RFI, three zones (upper, middle, and lower) in the fluvial deposits were characterized with 27 fluvial deposits monitoring wells and 80 DPT sampling locations. Vertically, the three zones are interconnected; however, as discussed previously in the report and shown in Figures A-2, A-3, and A-4 contaminant concentrations varied spatially with depth across the Apron Area.

Findings — Figures A-2, A-3, and A-4 illustrate the cumulative RBC exceedances in groundwater in the upper, middle and lower parts of the fluvial deposits beneath the Apron Area. VOCs, primarily trichloroethylene (TCE; maximum of 1,160 μg/L), 1,1-dichloroethylene (1,1-DCE; maximum of 290 μg/L), tetrachloroethylene (PCE; maximum of 120 μg/L), benzene (maximum of 653 μg/L), and carbon tetrachloride (maximum of 199 μg/L), were the primary contaminants identified in groundwater during the SWMU 7/Apron Area RFI. The potential risk varies up to three orders of magnitude and is associated with all three zones of the fluvial deposits. Section 5 provides a conceptual model for the numerous contaminant plumes and shows multiple, overlapping plumes with varying dimensions and chlorinated hydrocarbons.

Status — The SWMU 7/AOC A RFI is complete. The former dry well (SWMU 7) at Building N-126 has been removed under a Voluntary Corrective Action (VCA) and no further action has been recommended (EnSafe, February 20, 1998). Approval from the TDEC and USEPA are still pending. Groundwater contamination beneath Building N-126, discussed in Sections 4 and 5 of this report has been further evaluated in the *AOC A RRI Addendum* and will be addressed in the CMS for the Northside Fluvial Groundwater AOC A.

- *N-94 Underground Tank Farm (SWMU 15)* — This fuel farm, approximately 500 feet west of N-126 (Figure A-2), housed 10 underground storage tanks (USTs) ranging in volume from 10,000 to 25,000 gallons. Nine of the tanks stored aviation gas and one stored lubricating oil. The tanks supplied 75 remote fuel/oil pit boxes along the airport aprons

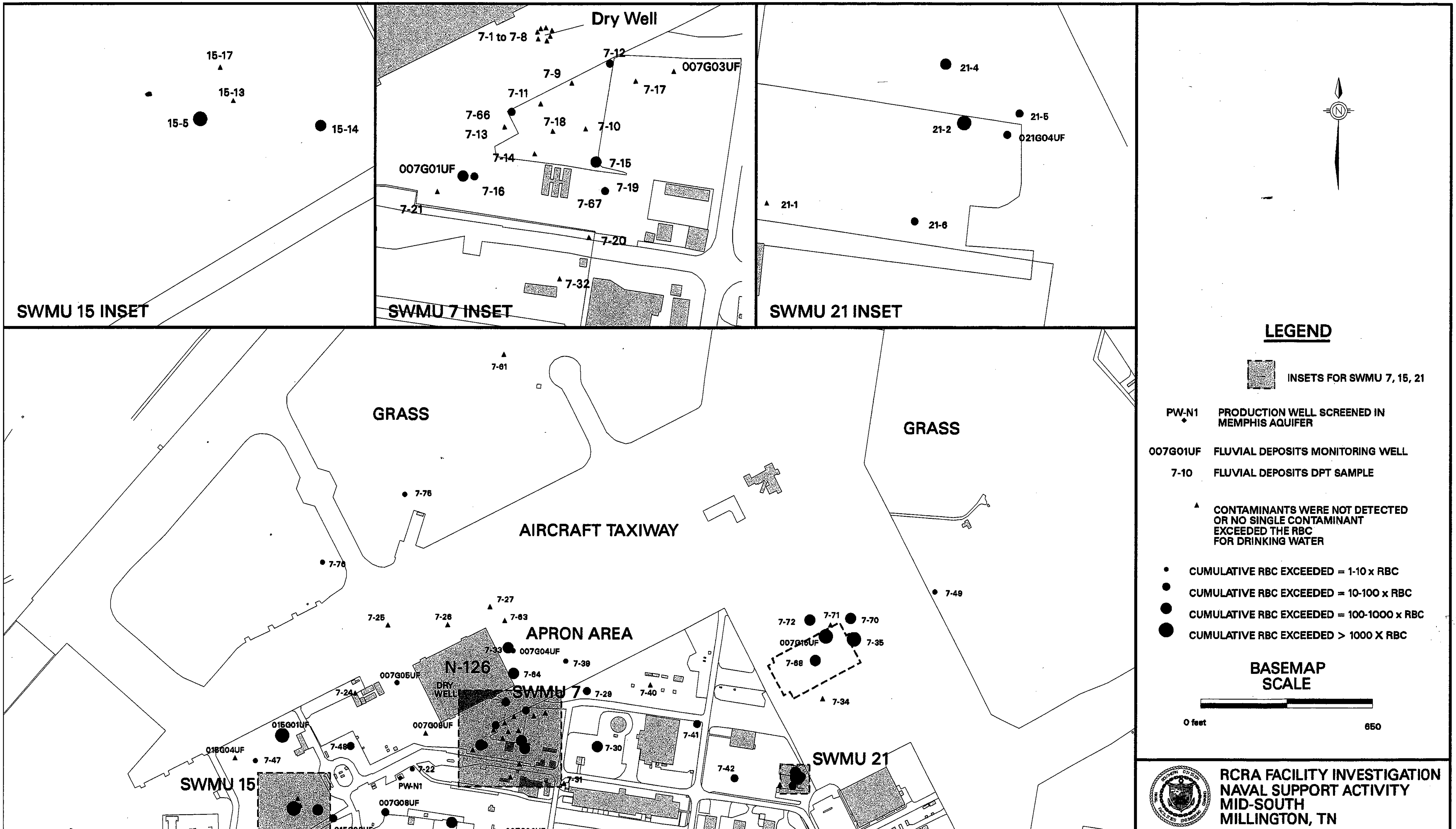


FIGURE A-2
CUMULATIVE RBC EXCEEDANCES
AREA A - UPPER FLUVIAL DEPOSITS
GROUNDWATER

This page intentionally left blank.

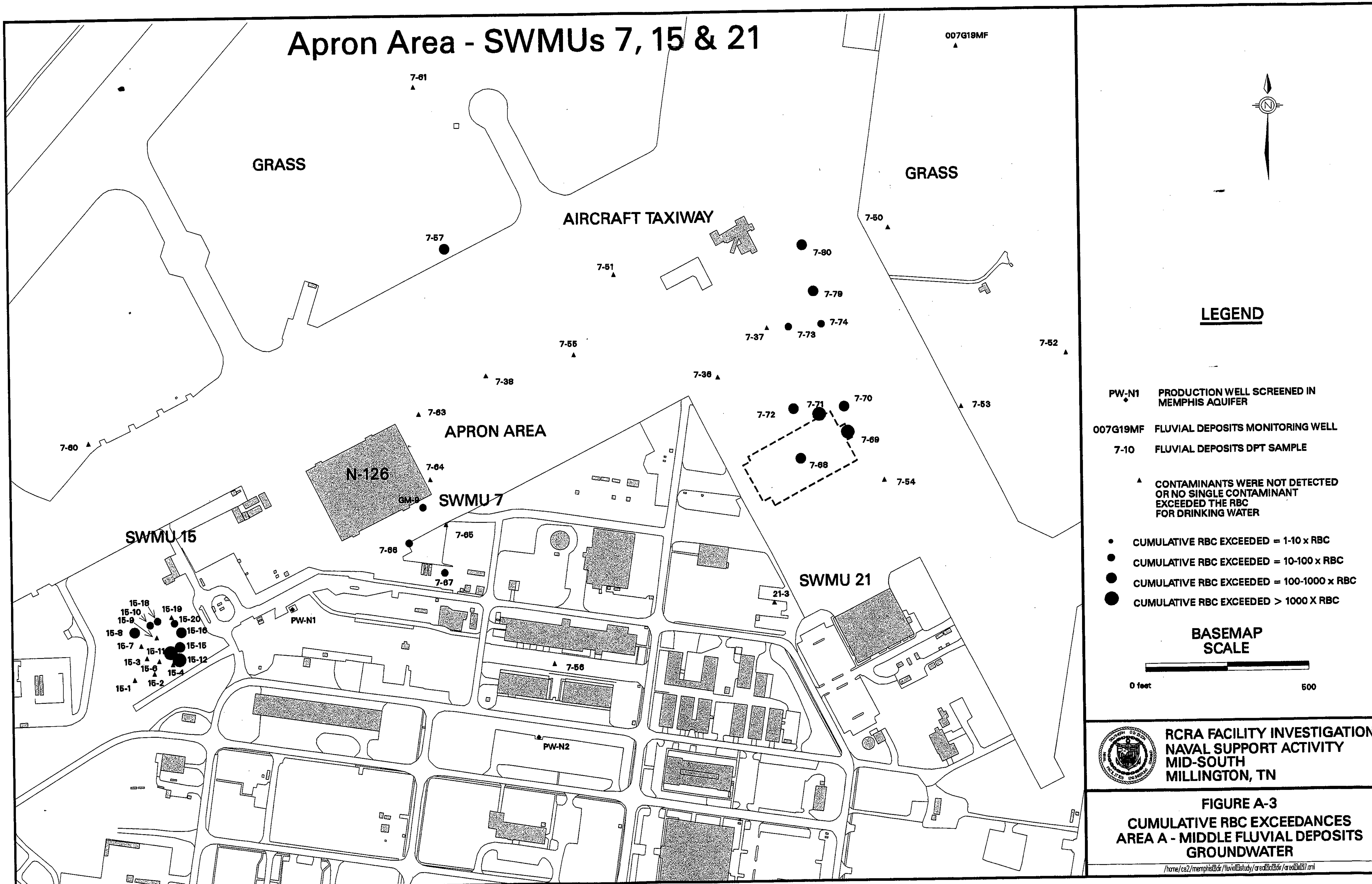
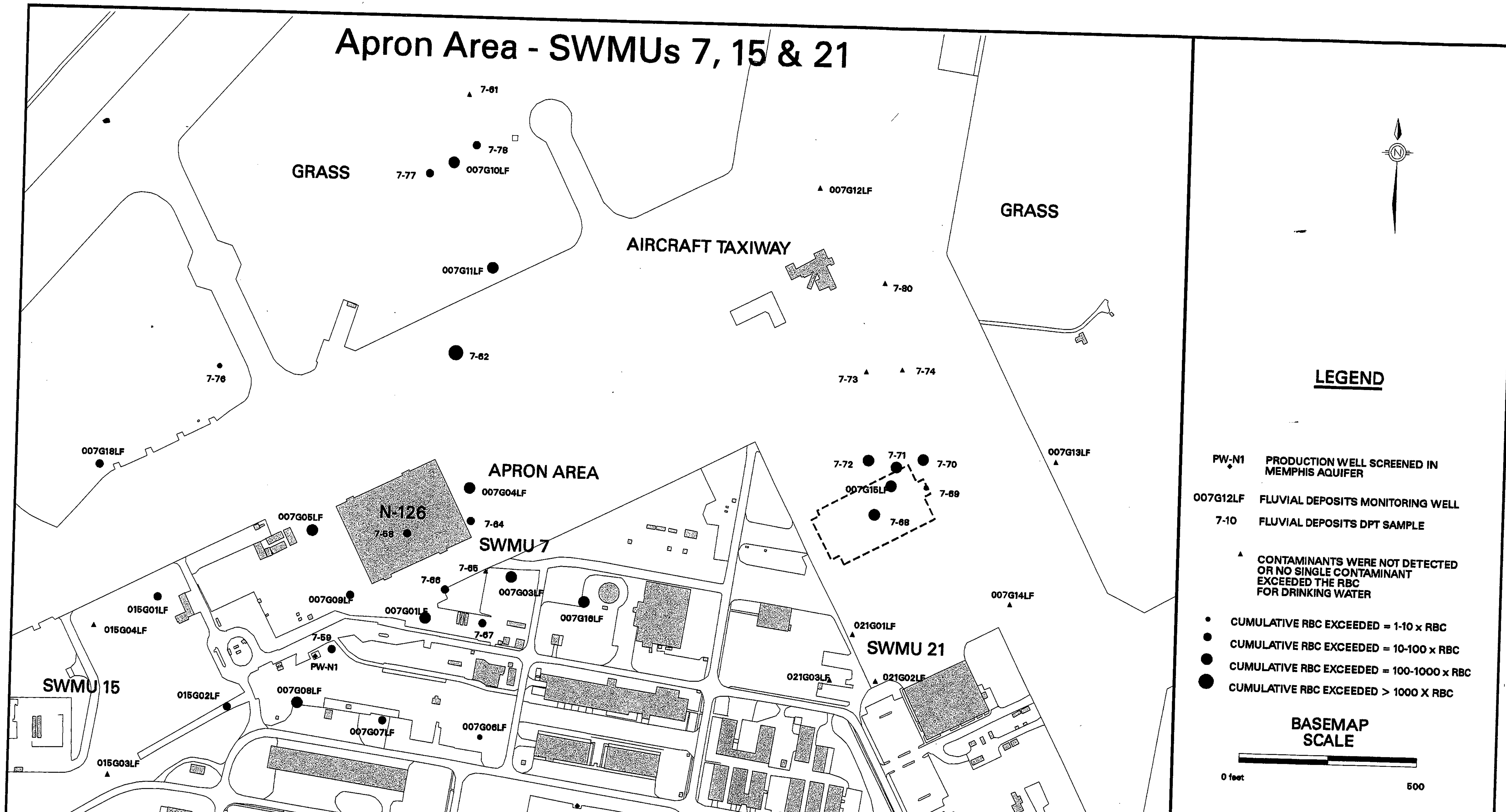


FIGURE A-3
CUMULATIVE RBC EXCEEDANCES
AREA A - MIDDLE FLUVIAL DEPOSITS
GROUNDWATER

This page intentionally left blank.

Apron Area - SWMUs 7, 15 & 21



RCRA FACILITY INVESTIGATION
NAVAL SUPPORT ACTIVITY
MID-SOUTH
MILLINGTON, TN

FIGURE A-4
CUMULATIVE RBC EXCEEDANCES
AREA A - LOWER FLUVIAL DEPOSITS
GROUNDWATER

This page intentionally left blank.

on either side of the control tower and serviced aircraft with fuel and lubricating oil while they were parked on the apron. The fuel/oil pit boxes were also referred to as the Aqua System. Five of the USTs stored liquid wastes between 1986 and 1992 and may have stored paint waste, solvents, Freon, strippers, waste oil, waste gas, and waste alodine. In March 1992, all the tanks and associated piping were removed under the Navy UST program (EnSafe, April 28, 1998).

Four upper and 16 middle fluvial deposits DPT groundwater samples were collected at the beginning of the RFI and analyzed for VOCs. The detection of petroleum constituents at concentrations exceeding MCLs and TDEC soil-cleanup goals warranted additional groundwater monitoring and resulted in four well pairs (Figures A-2 and A-4). Each pair contained an upper and lower fluvial deposits monitoring well, located at the four corners of the SWMU. Groundwater samples were analyzed for VOCs, SVOCs, metals, and TPH-DRO during the first sampling event and VOCs during the second sampling event.

Findings — Benzene, 1,1-DCE, carbon tetrachloride, TCE, TPH-DRO, cadmium, and arsenic exceeded their tap water RBCs in groundwater from at least one sample location and detections were generally consistent over sampling events (for monitoring wells only). The potential risk identified, based on sample results for groundwater from the upper fluvial deposits, was primarily attributed to benzene — detected at 10 of the 20 DPT locations and two of the four upper fluvial deposits monitoring wells. The highest concentration was detected in monitoring well 015G01UF, where 4,600 μg/L of benzene were detected. Additionally, petroleum contaminants exceeded cleanup goals and MCLs in the shallow loess soil and loess groundwater, indicating infiltration through this area has been transporting contaminants to the underlying fluvial deposits (EnSafe, April 24, 1998).

The potential risk from groundwater in the lower part of the fluvial deposits at SWMU 15 (Figure A-4) is primarily attributed to 1,1-DCE, carbon tetrachloride, TCE, and PCE. The absence of these contaminants in loess groundwater and soil during the SWMU 15 RFI suggests that their presence in the fluvial deposits are attributable to an upgradient source, southeast of SWMU 15, and likely related to the contamination identified south of N-126 (EnSafe, April 24, 1998).

Status — The SWMU 15 RFI is complete and the final report has been approved by the TDCE and USEPA. The product piping along with contaminated soil and groundwater (loess) in the former tank holds was removed under the Navy UST program. Groundwater contamination in the fluvial deposits of SWMU 15 will be addressed in the CMS for the Northside Fluvial Groundwater AOC A.

- *N-10 Underground Waste Tank (SWMU 21)* — A 3,000-gallon waste oil and hydraulic fluid UST was used by a former automobile and aircraft maintenance shop near former building N-10, approximately 800 feet east of N-126 hangar (Figure A-2). Four upper and one middle fluvial deposits groundwater samples were collected with DPT methods and analyzed for VOCs during the initial CSI phase. The presence of benzene and carbon tetrachloride in groundwater warranted the subsequent RFI and installation of the three lower and one upper fluvial deposits monitoring wells. Groundwater samples were submitted for FSA[1] during the initial sampling event and VOCs during the second sampling event.

[1]FSA includes VOCs, SVOCs, chlorinated pesticides/PCBs, organophosphorus pesticides, chlorinated herbicides, and metals (Appendix IX), TPH, and cyanide.

Findings — The potential risk posed by groundwater in the upper part of the fluvial deposits (Figure A-2) is a result of carbon tetrachloride, which was detected in four of the five DPT locations and the single upper fluvial deposits monitoring well. The highest carbon tetrachloride concentration (163 μg/L) was detected at upgradient DPT location 21-2 (Figure A-2), which led to the conclusion that the source of the contamination might be unrelated to SWMU 21 and possibly due to the MAG-41 (Marine Air Group 41) inactive drum storage area south of the SWMU (E/A&H, March 26, 1997). However, as discussed in Sections 3 and 4, the MAG-41 investigation found carbon tetrachloride in only one of five samples collected from the fluvial deposits and concentrations were less (0.87 μg/L) than those detected at SWMU 21 suggesting MAG-41 is not a source of carbon tetrachloride identified at SWMU 21.

Status — The SWMU 21 RFI is complete and has been approved by the TDEC and USEPA. Groundwater contamination in the fluvial deposits will be addressed in the CMS for the Northside Fluvial Groundwater AOC A.

A.1.2 Area B — SWMUs 3 and 40

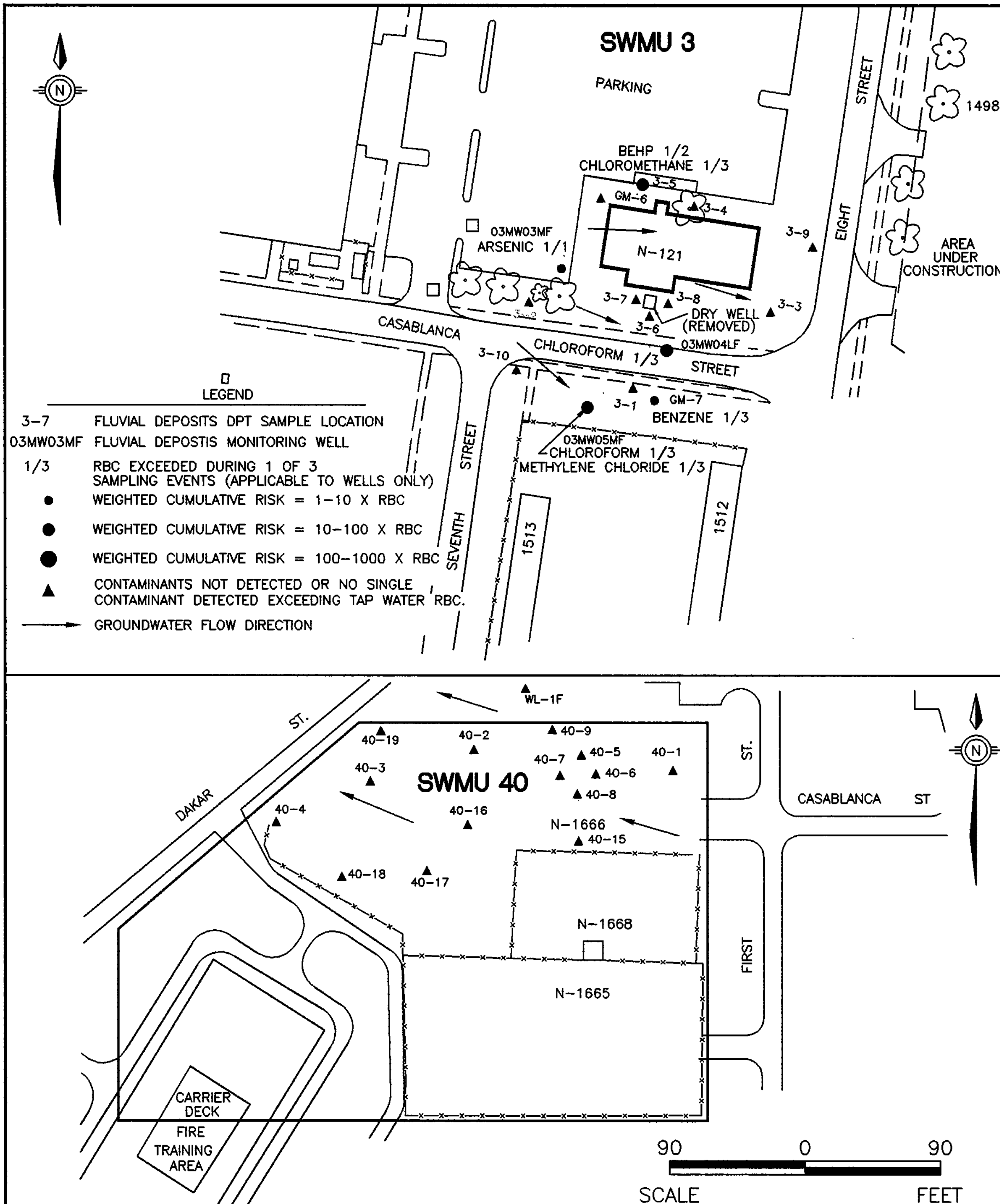
Area B comprises SWMUs 3 and 40 and represents the fluvial deposits groundwater within the south central portion of the Northside. Groundwater elevations collected from the fluvial deposits provided in Section 2 show this area is upgradient from the Apron Area.

- *Building N-121 Plating Shop Dry Well (SWMU 3)* —Plating wastes generated from former N-121 plating operations were reportedly disposed in a dry well, next to the south side of the building. The RFI began with the analyses of 10 upper fluvial groundwater samples collected through DPT methods. Two existing fluvial deposits wells were supplemented during the RFI with three additional fluvial deposits wells, which were initially sampled for a modified FSA, cyanide, and TPH and subsequently sampled three more times as part of the Navy's long-term groundwater monitoring of Assembly A SWMUs.

Findings — As shown in Figure A-5 and Table A-2, no VOCs were detected in the groundwater samples collected through DPT methods. The following contaminants were detected in monitoring wells above their respective RBCs: chloroform, chloromethane, methylene chloride, bis(2-ethylhexyl)phthalate (BEHP) and benzene. Figure A-5 shows that these contaminants vary spatially across the site. Detection frequencies have been inconsistent during the course of monitoring (E/A&H, April 15, 1996).

Status — The SWMU 3 RFI is complete and no further action has been recommended for SWMU 3 (E/A&H, April 15, 1996). Final approval of the report has been received from TDEC and USEPA. The dry well was removed under a VCA on September 25, 1996 (EnSafe, February 20, 1998).

- *Former Salvage Yard No. 1 (SWMU 40) and Former Service Station* — SWMU 40 (Figure A-1) is a parking area formerly used to store scrap pieces of airplanes, anchor chains, vehicles, and other hardware. A service station formerly occupying the north central portion of the SWMU housed two USTs (1,000 and 2,000 gallon capacities) that were reportedly abandoned in place. A 1996 geophysical survey indicated the USTs and the associated fuel lines were present (E/A&H, October 7, 1996). These were removed in 1997. Petroleum constituents (VOCs, SVOCs, and TPH) identified in shallow loess soil and groundwater near the tank and former pump island were addressed under the TDEC UST program. Fourteen DPT groundwater samples collected from the fluvial deposits were analyzed for VOCs during the RFI. Additionally, an observation well (WL-1F) constructed by the USGS for use during an aquifer test of the fluvial deposits was sampled and analyzed for VOCs.



RCRA FACILITY INVESTIGATION
NAVAL SUPPORT ACTIVITY MID-SOUTH
MILLINGTON, TN

FIGURE A-5
AREA B – SWMUs 3 AND 40
CUMULATIVE RBC EXCEEDANCES –
FLUVIAL DEPOSITS GROUNDWATER

DWG DATE: 01/17/00 | DWG NAME: 94ABCRF

This page intentionally left blank.

Findings — As shown on Figure A-5, no VOCs were detected above their RBCs.

Status — The SWMU 40 RFI is complete. No further action was recommended in the RFI which has been approved by the USEPA and TDEC (E/A&H, October 7, 1996).

A.1.3 Area C — Background Location 5 and SWMUs 5, 27, 10, and 60

Area C comprises SWMUs 5, 27, 10, and 60, and background location 5 and encompasses the fluvial deposits groundwater within the southwest portion of the Northside (Figure A-1).

- *Aircraft Fire Fighting Training Facility (AFFTF; SWMU 5)* — The AFFTF (Figure A-1) was used to simulate fire-rescue situations by igniting JP-4, JP-5, and waste fuels within two double-bermed concrete mats approximately 75 feet in diameter, each containing a mock aircraft cockpit in the center. Three 2-foot by 8-foot by 1-foot rectangular, concrete-lined pits located north of the mats were also used for fire-extinguisher training. The AFFTF was active between 1949 and October 1996 and has a history of leaking USTs, ruptured drain lines, tank overflows, and spills. An oil-water separator/fuel-recycling system was installed in 1977. Before then, spent fuel and waste discharges from the facility flowed directly to the drainage ditch (SWMU 4) on the north side of the site (Figures A-1 and A-6). Overflows of JP-5 fuel from the nearby Carrier Deck Facility oil-water separator, located approximately 1,000 feet east of the AFFTF, reached the southwest corner of the AFFTF via sewer lines and may also have impacted SWMU 5 (E/A&H, May 6, 1997).

Findings — Fourteen DPT groundwater samples were collected from the fluvial deposits at SWMU 5; benzene was detected in one sample from beneath the former fire extinguisher pit (location 5-7 on Figure A-6 — 5.7 μg/L). Petroleum constituents (benzene and TPH) exceeding the MCLs or TDEC's total TPH soil cleanup levels were detected in loess groundwater and soil in this area and are the likely sources for the deeper benzene detection. The most significant contamination found at SWMU 5 was carbon tetrachloride, detected near the southeast corner of the site (Figure A-6; wells 005G04AUF, 005G04BUF, and 005G04UF). The source of the carbon tetrachloride is unknown because it was not detected in the loess soil or groundwater at SWMU 5. SWMUs 19 and 49, a closed underground waste tank and a hazardous waste accumulation point at the Navy Exchange Service Station, are adjacent and upgradient to the southeast portion of SWMU 5. However, investigation of these SWMUs found they were not source areas to the carbon tetrachloride as detected at SWMU 5 (EnSafe, February 20, 1998). Additional work has been conducted at the southeast corner of the SWMU in an attempt to identify the source of the carbon tetrachloride, however, no source was identified.

As shown in Figure A-6, chloromethane exceeded its tap water RBC in one well during one of four sampling events and lead was detected in the same well at a concentration exceeding its background RC and treatment technique action level (TTAL).

Status — Further evaluation of the SWMU 5's southeast corner did not identify a source the carbon tetrachloride identified in the fluvial deposits groundwater. The final RFI report has been approved by the TDEC and USEPA. VOCs in the fluvial deposits groundwater will be addressed in the AOC A CMS. Petroleum constituents in loess soil were removed in November 1997 under a VCA (EnSafe, report in preparation) and remaining loess groundwater contamination will be addressed in the CMS for Northside loess groundwater.

- *Background Location 5* — The well cluster at background location BG- 5, which includes one upper fluvial deposits well (0BGG05UF), one lower fluvial deposits well (0BGG05LF), and one loess well (0BGG05LS), is one of 13 background well clusters used to characterize the ambient water quality in the loess and fluvial deposits in areas away from SWMUs at NSA Mid-South. During the initial RFI sampling of these wells, 17 μg/L

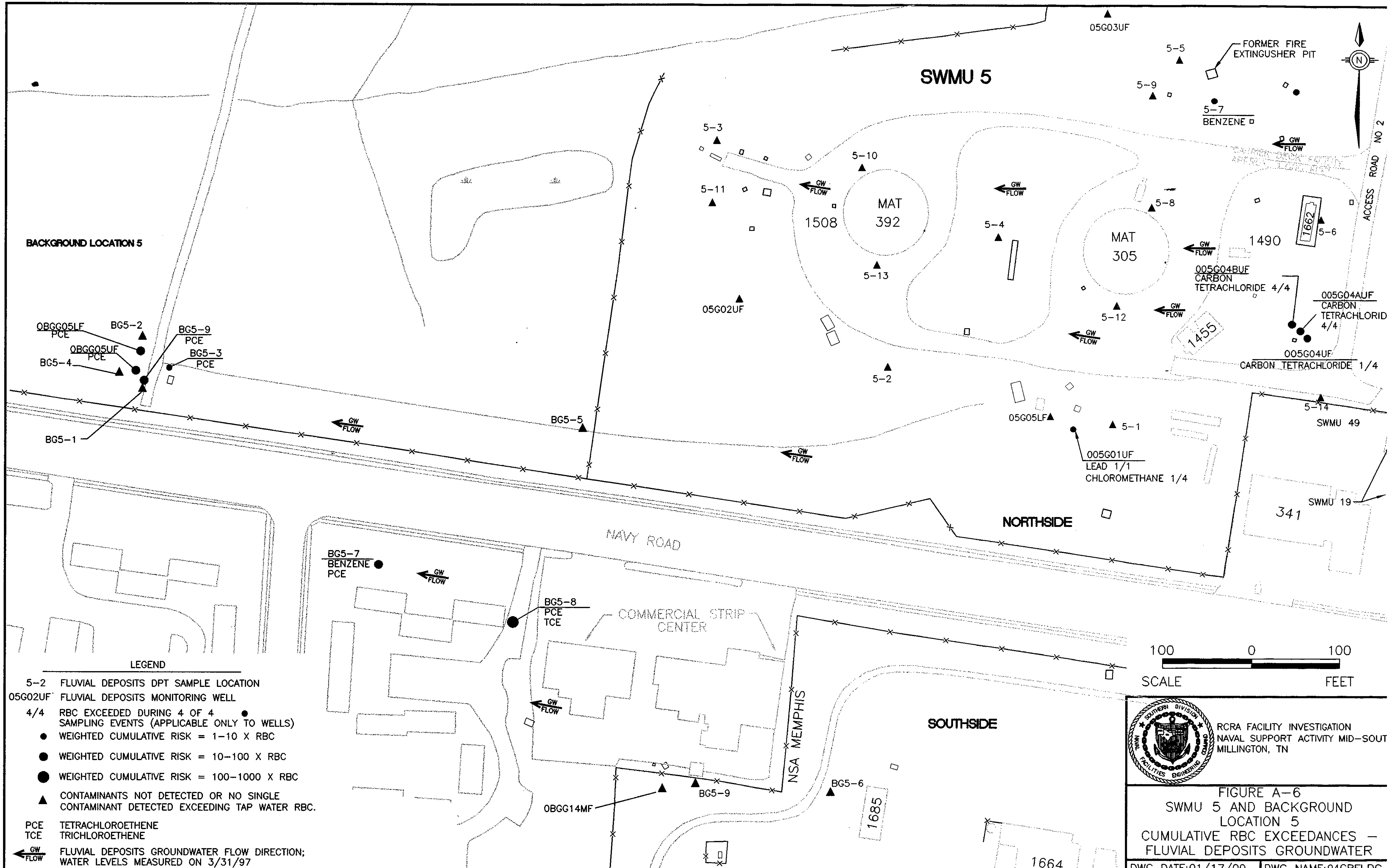


FIGURE A-6
SWMU 5 AND BACKGROUND LOCATION 5
CUMULATIVE RBC EXCEEDANCES – FLUVIAL DEPOSITS GROUNDWATER

This page intentionally left blank.

PCE were detected in groundwater samples from well 0BGG05UF and 27 μg/L were detected in well 0BGG05LF, both of which exceeded its 1.1 μg/L tap water RBC. To identify the PCE source, groundwater samples were collected from the fluvial deposits during three separate DPT investigations conducted around and near the background well cluster. An additional background monitoring well (Figure A-6; well 0BGG14MF) was also installed near the northwest corner of the NSA Mid-South Southside to better define the potentiometric surface between the Southside and location BG-5.

Findings — The distribution of contaminants coupled with potentiometric data indicate that the PCE found in the fluvial deposits groundwater at location BG-5 is not originating from Navy property, but likely from the strip shopping center on the south side of Navy Road (Figure A-6). The magnitude of the PCE tap water RBC exceedances in groundwater is shown in Figure A-6 to increase toward the shopping center. Groundwater samples collected southwest and south of the shopping center (BG5-6, BG5-9, and well BGG14MF) contained no PCE, indicating the contamination is not originating from the NSA Mid-South Southside (E/A&H, June 20, 1997). Additionally, no PCE was detected at SWMU 5. The source of the PCE is believed to be a commercial dry-cleaning facility within the shopping center — PCE is a commonly used commercial dry-cleaning solvent.

Status — Further investigation of the PCE detected at BG-5 is being handled by the TDEC Division of Superfund and is outside the scope of this investigation.

- *Northside Sewage Treatment Plant (SWMU 27)* —The former Northside sewage-treatment plant (Figures A-1 and A-7) was constructed in 1943 and consisted of a digester tank, a control house, six treatment tanks, and four sludge drying beds. The facility received mostly sanitary waste from the Northside; however, between the 1940s and 1950s, some industrial waste solvents (oils, solvents, and paints) were reportedly discharged to the sewage system from various on-base operations. Drying beds rested on native soil and were considered potential release points for sewage-treatment plant contaminants to groundwater. The facility reportedly operated until the late 1940s to early 1950s.

Findings — As part of the CSI conducted at SWMU 27, six DPT groundwater samples were collected from the fluvial deposits beneath the former sludge drying beds and analyzed for VOCs. As shown on Figure A-7, no VOCs were detected in fluvial deposits groundwater at concentrations exceeding the RBCs (E/A&H, December 16, 1996).

Status — The CSI is complete and no further action has been recommended for SWMU 27 (E/A&H, December 16, 1996). The report has received final approval from the USEPA and TDEC.

- *Construction Debris Landfill (SWMU 10)* — This SWMU is the eastern portion of the Northside Landfill (SWMU 60; Figures A-1 and A-8) that was used for disposal of construction debris and other inert materials from 1951 to 1986. The landfill was not originally recommended for study; however, the BCT recommended further study after the detection of petroleum contaminants in sediment both in and downgradient of the drainage ditch adjacent to the landfill (SWMU 38). Eighteen fluvial deposits DPT groundwater samples were collected as part of the SWMU 10 CSI and analyzed for VOCs.

Findings — Methylene chloride (Figure A-8) was detected in groundwater from the fluvial deposits at one location at a concentration exceeding its tap water RBC. The source may be the methylene chloride detected in the overlying loess groundwater and soil (EnSafe, January 16, 1998).

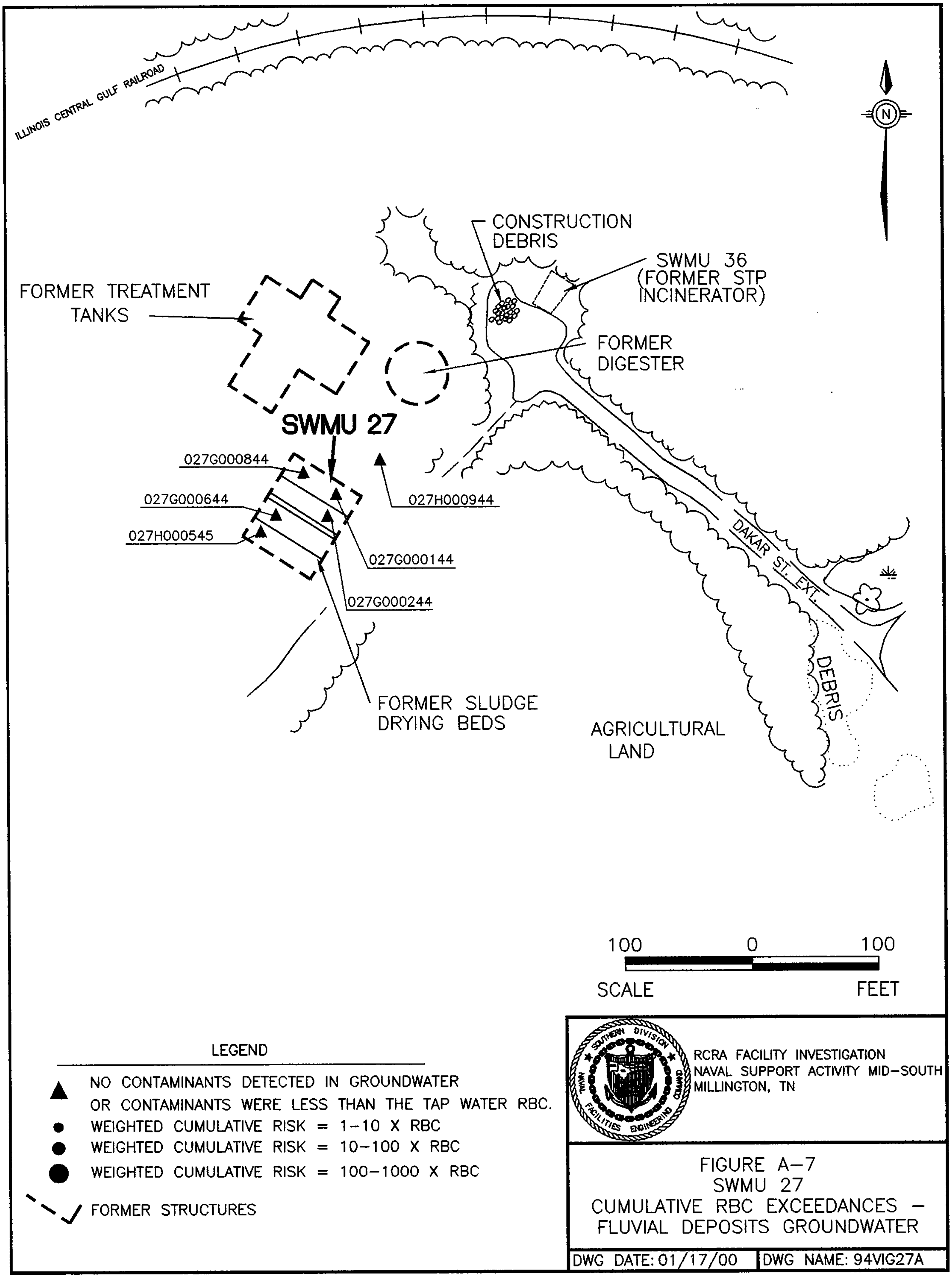
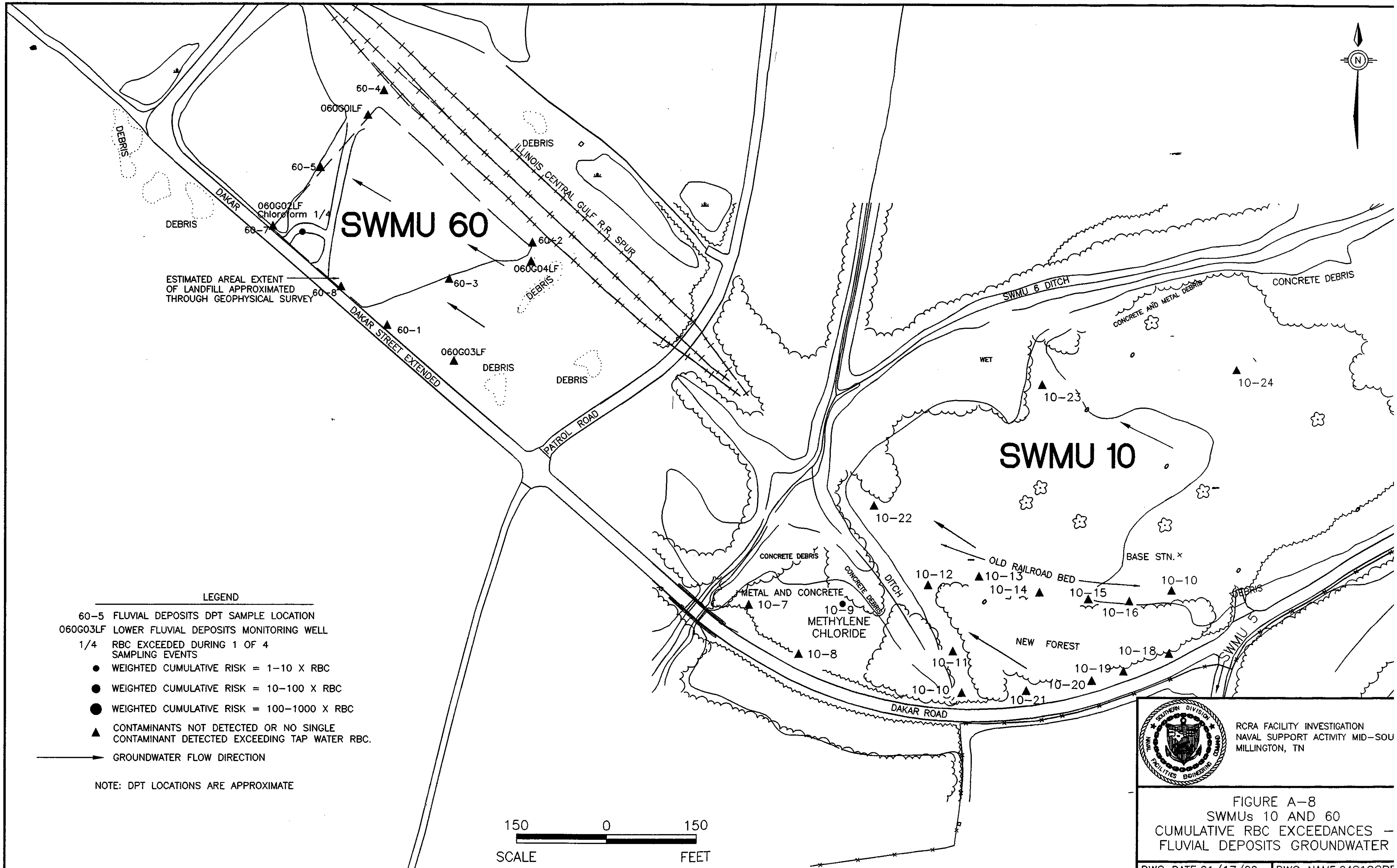


FIGURE A–7
SWMU 27
CUMULATIVE RBC EXCEEDANCES –
FLUVIAL DEPOSITS GROUNDWATER

This page intentionally left blank.


SWMU 60
SWMU 10
DEBRIS
60-4
060G01LF
60-5
060G02LF
Chloroform 1/4
60-7
60-2
060G04LF
60-3
60-8
60-1
060G03LF
ESTIMATED AREAL EXTENT OF LANDFILL APPROXIMATED THROUGH GEOPHYSICAL SURVEY
DAKAR
DAKAR STREET EXTENDED
ILLINOIS CENTRAL GULF R.R. SPUR
PATROL ROAD
SWMU 6 DITCH
CONCRETE AND METAL DEBRIS
CONCRETE DEBRIS
WET
10-23
10-24
10-22
OLD RAILROAD BED
BASE STN.
10-12
10-13
10-14
10-15
10-16
10-10
METAL AND CONCRETE
10-7
10-9
METHYLENE CHLORIDE
10-8
DITCH
NEW FOREST
10-11
10-18
10-19
10-20
10-21
DAKAR ROAD
SWMU 5
LEGEND
60-5 FLUVIAL DEPOSITS DPT SAMPLE LOCATION
060G03LF LOWER FLUVIAL DEPOSITS MONITORING WELL
1/4 RBC EXCEEDED DURING 1 OF 4 SAMPLING EVENTS
WEIGHTED CUMULATIVE RISK = 1-10 X RBC
WEIGHTED CUMULATIVE RISK = 10-100 X RBC
WEIGHTED CUMULATIVE RISK = 100-1000 X RBC
CONTAMINANTS NOT DETECTED OR NO SINGLE CONTAMINANT DETECTED EXCEEDING TAP WATER RBC.
GROUNDWATER FLOW DIRECTION
NOTE: DPT LOCATIONS ARE APPROXIMATE
150 0 150
SCALE FEET
N
RCRA FACILITY INVESTIGATION
NAVAL SUPPORT ACTIVITY MID-SOU
MILLINGTON, TN
FIGURE A-8
SWMUs 10 AND 60
CUMULATIVE RBC EXCEEDANCES –
FLUVIAL DEPOSITS GROUNDWATER
DWG DATE:01/17/00
DWG NAME:94S10CRF

This page intentionally left blank.

Status — The CSI report recommended no further action for SWMU 10 and concluded that the potential risk associated with the contaminants does not exceed the risk threshold for planned reuse of this land as an industrial/commercial scenario (EnSafe, January 16 1998). The SWMU 10 CSI has been approved by the USEPA and TDEC.

- *Northside Landfill (SWMU 60)* — This SWMU which includes the western portion of the Northside landfill (Figures A-1 and A-8), which received demolition debris and construction materials between 1951 and 1986. An abandoned (possibly discarded) steel storage tank was identified at the landfill in 1980. The RFI began with the collection of seven DPT groundwater samples from the fluvial deposits that were analyzed for VOCs. Later RFI activities included the installation and sampling of four monitoring well pairs located at the four corners of the landfill perimeter. The well pairs were screened in the loess and lower part of the fluvial deposits.

Findings — As shown on Figure A-8, VOCs were either non-detect or below the tap water RBC in the upper part of the fluvial deposits collected during the DPT investigation. Chloroform exceeded its tap water RBC (0.15 μg/L) in the second (confirmatory) well sampling event, however, it was absent in the subsequent two sampling events. No inorganics were detected in excess of their RC and/or RBC (E/A&H, April 4, 1997).

Status — The SWMU 60 RFI report has been approved by the TDEC and USEPA. Petroleum contamination identified in loess soil and loess groundwater at the northwest corner of the landfill was removed through a VCA in November 1997. Additionally, hot spots of surface soil contaminated with petroleum hydrocarbons were also removed from the landfill cover. No further action has been recommended for SWMU 60.

A.1.4 Area D — North Fuel Farm

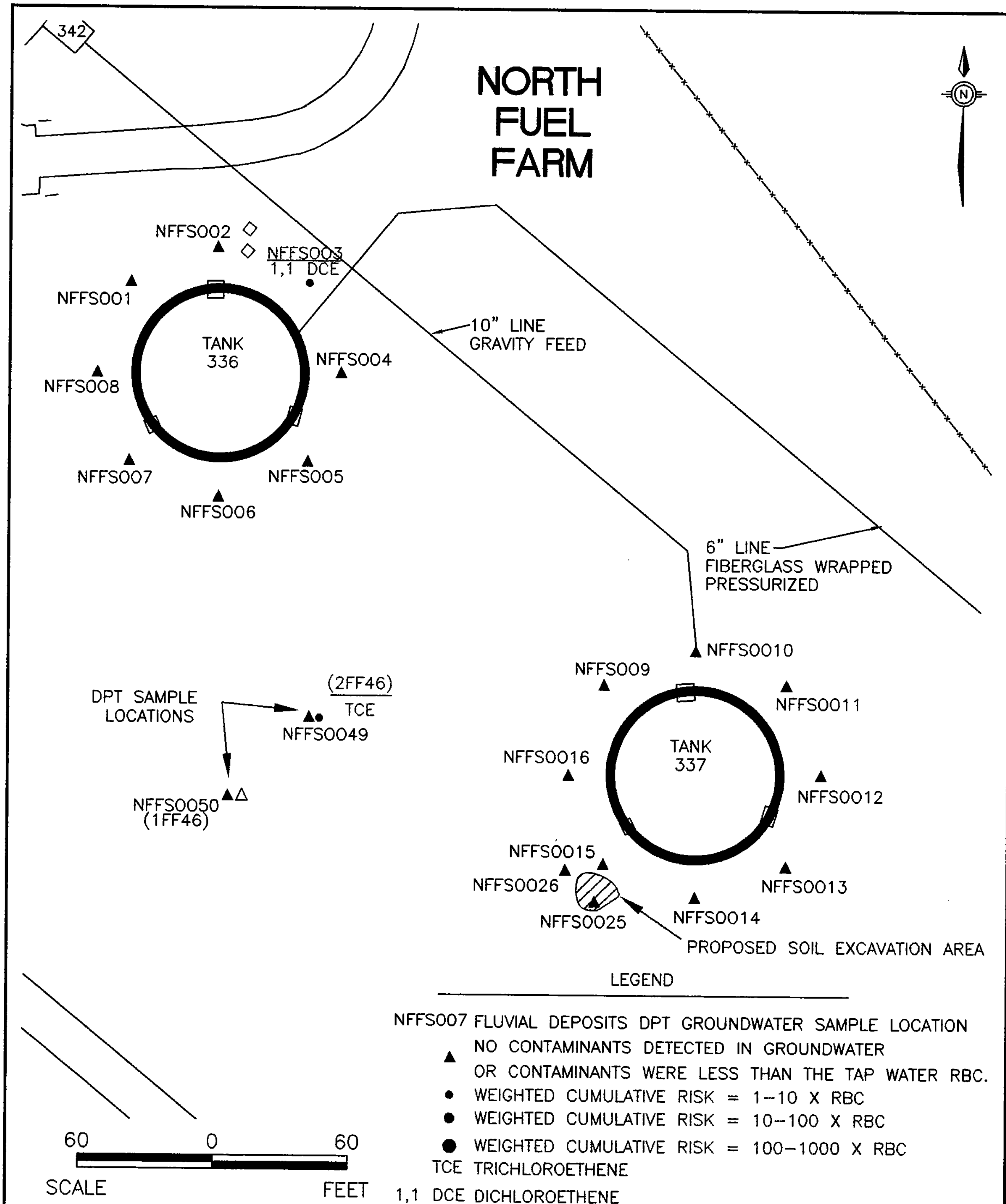
The *North Fuel Farm* is the only site within Area D (Figures A-1 and A-9) and contains two 420,000-gallon field-constructed, concrete tanks and associated piping (Tanks 336 and 337). The site was initially investigated in 1995 by collection of two fluvial deposits groundwater samples using DPT methods. Groundwater samples were again collected with DPT methods from the fluvial deposits at 18 locations surrounding the two tanks and from the previous two sample locations in June of 1996.

Findings — TCE was detected in one of two initial samples (location 2FF46) at a concentration of 6.8 μg/L, which exceeds its 1.6 μg/L tap water RBC; however, its presence was not confirmed during the second sampling event. The only VOC detected during the second DPT sampling event was 1,1-DCE at a concentration of 2.2 μg/L at location NFFS003 which exceeded its 0.04 μg/L tap water RBC (E/A&H, April 11, 1997).

Status — Subsurface soil containing petroleum contaminants at concentrations exceeding TDEC's soil cleanup levels near Tank 337 was removed through a VCA in January 1998. The tanks are to be cleaned and left in place for industrial reuse as nonpotable water reservoirs for fire protection. No further action or investigation has been recommended for loess or fluvial deposits groundwater in the North Fuel Farm area. The report has been approved by the TDEC and USEPA.

A.1.5 Area E — SWMUs 1 and 62

- *Fire Department Drill Area (FDDA; SWMU 1)* — SWMU 1 (Figure A-1 and A-10) was used as a simulated crash site for fire-fighting training from 1960 through 1984. Fire training consisted of spraying fuel on an aircraft shell within a 20-foot square box, igniting it, and extinguishing the fire. Remnants of the FDDA consist of a 20-foot by 20-foot area enclosed by railroad rails formerly used for the burning operations and a 6-foot high soil

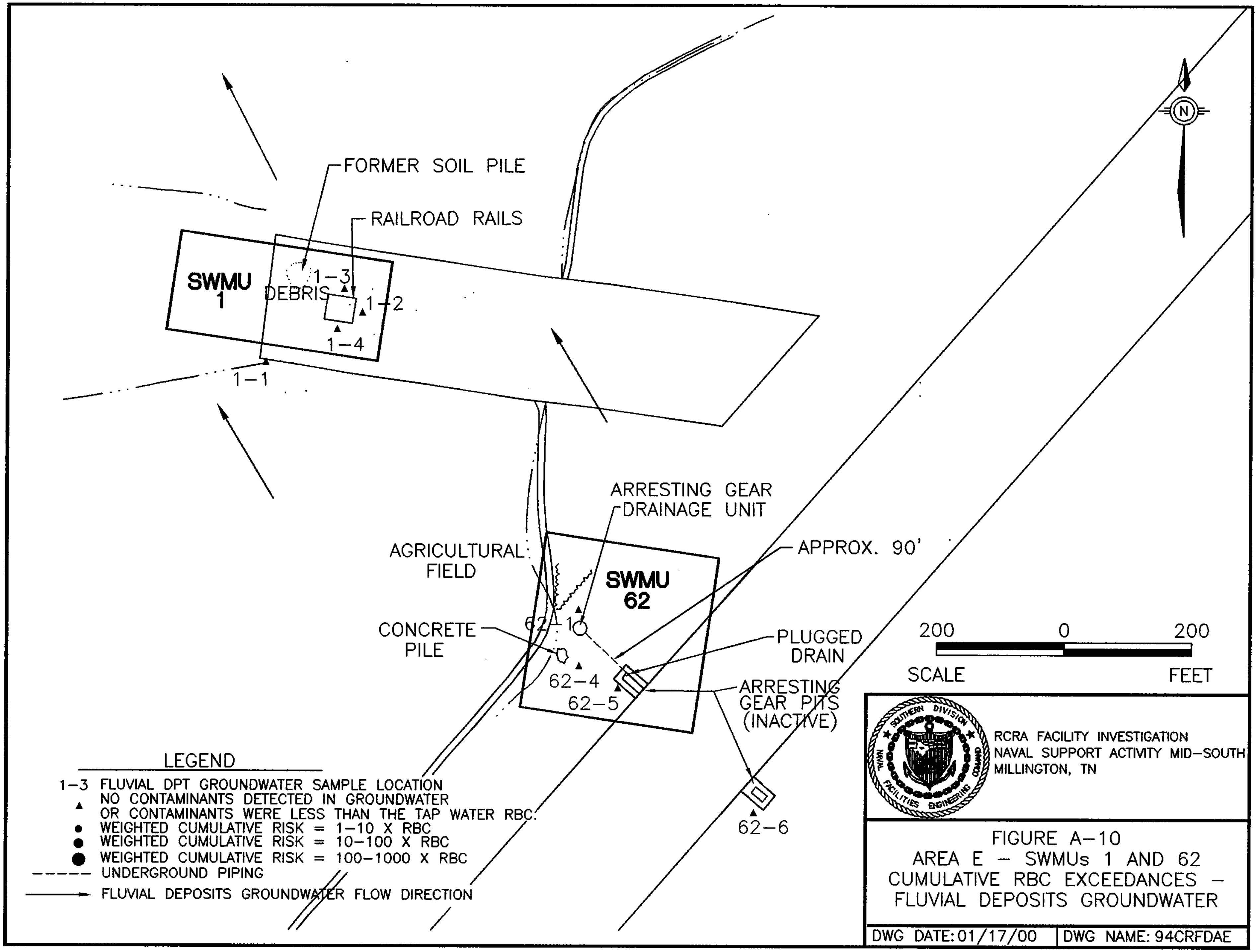


RCRA FACILITY INVESTIGATION
NAVAL SUPPORT ACTIVITY MID-SOUTH
MILLINGTON, TN

FIGURE A–9
NORTH FUEL FARM
CUMULATIVE RBC EXCEEDANCES – FLUVIAL DEPOSITS GROUNDWATER

DWG DATE: 01/17/00 | DWG NAME: 94FF336A

This page intentionally left blank.


FORMER SOIL PILE
RAILROAD RAILS
SWMU 1
1-3
DEBRIS
1-2
1-4
1-1
ARRESTING GEAR DRAINAGE UNIT
APPROX. 90'
AGRICULTURAL FIELD
SWMU 62
62-1
CONCRETE PILE
62-4
62-5
PLUGGED DRAIN
ARRESTING GEAR PITS (INACTIVE)
62-6
200 0 200
SCALE FEET
LEGEND
1-3 FLUVIAL DPT GROUNDWATER SAMPLE LOCATION
NO CONTAMINANTS DETECTED IN GROUNDWATER OR CONTAMINANTS WERE LESS THAN THE TAP WATER RBC.
WEIGHTED CUMULATIVE RISK = 1-10 X RBC
WEIGHTED CUMULATIVE RISK = 10-100 X RBC
WEIGHTED CUMULATIVE RISK = 100-1000 X RBC
UNDERGROUND PIPING
FLUVIAL DEPOSITS GROUNDWATER FLOW DIRECTION
SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
RCRA FACILITY INVESTIGATION
NAVAL SUPPORT ACTIVITY MID-SOUTH
MILLINGTON, TN
FIGURE A-10
AREA E - SWMUs 1 AND 62
CUMULATIVE RBC EXCEEDANCES -
FLUVIAL DEPOSITS GROUNDWATER
DWG DATE: 01/17/00
DWG NAME: 94CRFDAE

This page intentionally left blank.

pile. The SWMU contained two aboveground storage tanks within an asphalt containment-area boxed by the railroad-rails. Before the late 1970s, no containment (i.e., railroad rails) was in place. Aviation and waste fuels were used in the burning operations.

DPT groundwater samples were collected from the fluvial deposits at four locations (Figure A-10) and analyzed for VOCs. No VOCs were detected in the samples. Although acetone and carbon disulfide were detected in two duplicate samples, they were at concentrations less than the tap-water RBCs. Contaminants in soil were limited to an isolated surface soil area where a TPH concentration of 390 mg/kg was detected in a surface soil sample (E/A&H, September 18, 1996).

Status — A 6-foot high soil pile was removed under a VCA and transported offsite for disposal as a nonhazardous, special waste in June 1996. No further action has been recommended for SWMU 1 (E/A&H, March 19, 1997). The RFI report has been approved by the TDEC and USEPA.

- *M-21 Arresting Gear (SWMU 62)* — This SWMU, located adjacent to Runway 4-22 (Figure A-1 and A-10) was the former site of an airplane arresting gear mechanism. The arresting gear was housed in two cement-lined containment pits on either side of the runway. A 6-inch diameter PVC drain line was installed in the L-shaped containment pit located on the west side of the runway to drain rainwater which might otherwise collect in the pit. The drain line led rainwater and residual contaminants (hydraulic fluid, diesel fuel, and lube oil) from the arresting gear pit into a sump where residual contaminants floating on the water were periodically removed.

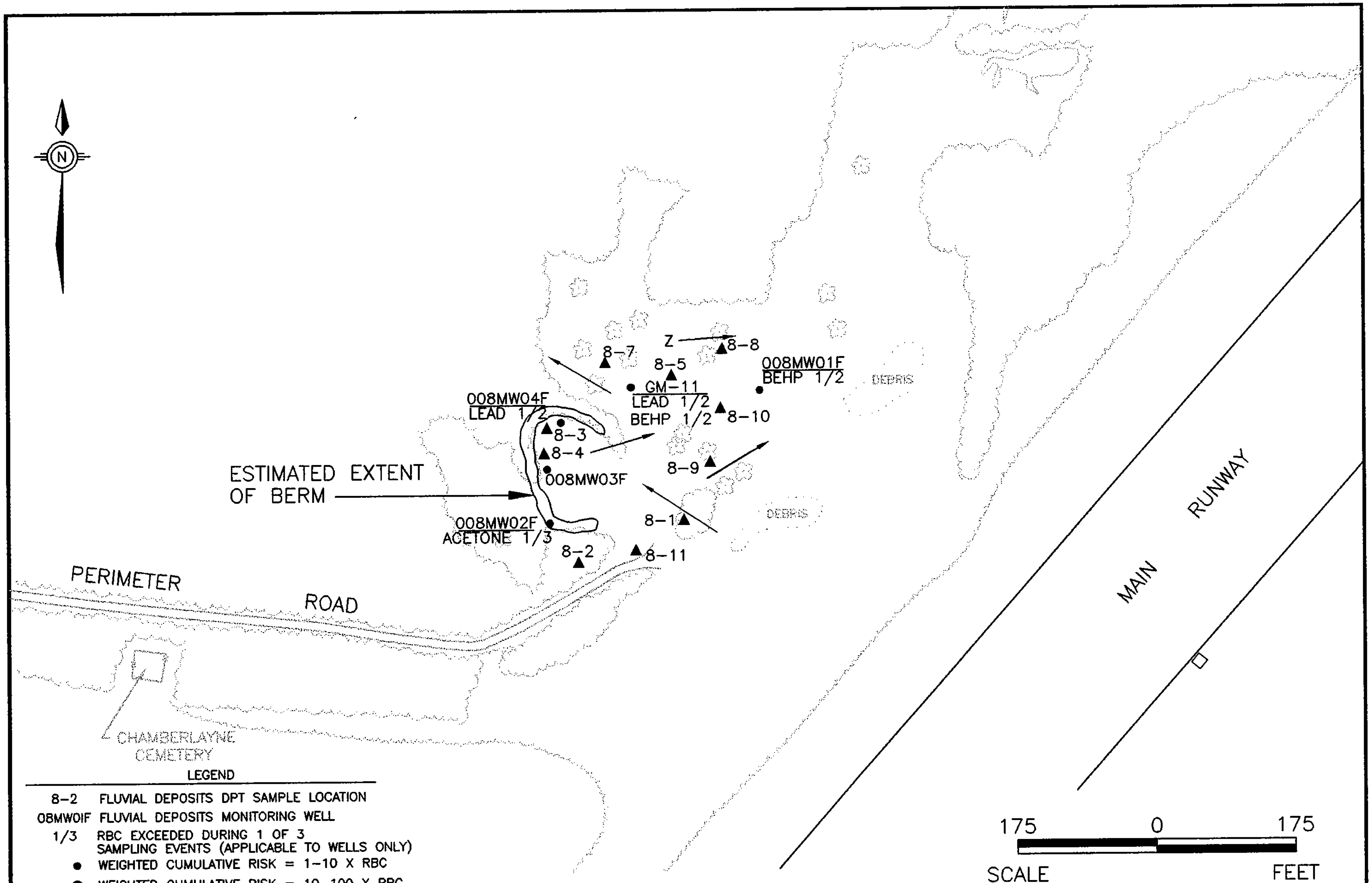
Findings — As part of the CSI conducted at SWMU 62, DPT groundwater samples were collected from the fluvial deposits at four locations and analyzed for VOCs. As shown in Figure A-10, no VOCs exceeded their tap water RBCs (E/A&H, December 16, 1996).

Status — Based on the findings of the CSI, no further action was recommended for SWMU 62 (E/A&H, December 16, 1996). The CSI report received final approval from TDEC and USEPA.

A.1.6 Area F — SWMU 8

The *Cemetery Disposal Area (SWMU 8)* is the northernmost SWMU within the Northside (Figures A-1 and A-11) and reportedly received solid and hazardous waste from 1965 to 1980. Canisters of ethylene oxide, metallic scrap, waste chemicals, waste oil, cleaning solutions, transformers, and capacitors were allegedly disposed at the site (ERC/EDGe, 1990). Ten groundwater samples were collected from the fluvial deposits using DPT methods at the beginning of the RFI and analyzed for VOCs. Additionally, one existing and four newly installed fluvial deposits monitoring wells were sampled for a modified FSA.

Findings — As shown on Figure A-11, no VOCs were detected above the RBCs in the 10 fluvial deposits groundwater samples collected using DPT methods. BEHP was detected in two monitoring wells and acetone was detected in one monitoring well; both compounds exceeded their RBCs (Figure A-11). Lead was the single inorganic in groundwater exceeding its background RC and the TTAL. However, the detection of these contaminants was not consistent during monitoring and it was concluded that the risk posed by these contaminants was minimal and acceptable to potential groundwater users (E/A&H, November 6, 1996). Approximately 270 cubic yards of soil dumped at the site and contaminated with pesticides and SVOCs has been removed. During recent grading activities (February 1998) several cylinders of ethylene oxide were unearthed which resulted in the identification and removal of 139 cylinders (EnSafe, SWMU 8 RFI report in preparation).



LEGEND

8-2 FLUVIAL DEPOSITS DPT SAMPLE LOCATION
08MW01F FLUVIAL DEPOSITS MONITORING WELL
1/3 RBC EXCEEDED DURING 1 OF 3 SAMPLING EVENTS (APPLICABLE TO WELLS ONLY)
● WEIGHTED CUMULATIVE RISK = 1-10 X RBC
● WEIGHTED CUMULATIVE RISK = 10-100 X RBC
● WEIGHTED CUMULATIVE RISK = 100-1000 X RBC
▲ CONTAMINANTS NOT DETECTED OR NO SINGLE CONTAMINANT DETECTED ABOVE TAP WATER RBC.
BEHP BIS(2-ETHYLHEXYL)PHTHALATE
FLUVIAL DEPOSITS GROUNDWATER FLOW DIRECTION (03-31-95)
FLUVIAL DEPOSITS GROUNDWATER FLOW DIRECTION (9-27-95)

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

RCRA FACILITY INVESTIGATION
NAVAL SUPPORT ACTIVITY MID-SOUTH
MILLINGTON, TN

FIGURE A-11
SWMU 8
CUMULATIVE RBC EXCEEDANCES -
FLUVIAL DEPOSITS GROUNDWATER

DWG DATE: 01/17/00 | DWG NAME: 94S8CRFD

This page intentionally left blank.

Status — No further action has been recommended for SWMU 8. The RFI report has been approved by the TDEC and USEPA.

A.2 MCL Exceedances in Fluvial Deposits Groundwater

SWMUs in Areas A (SWMUs 7, 15, and 21 [Apron Area]) and Area B (SWMU 5) warrant corrective measures as a result of groundwater contaminants identified in the fluvial deposits above the MCLs. Contaminants detected in the fluvial deposits groundwater in excess of the MCLs are discussed and shown with symbols scaled according to their cumulative MCL exceedances. The figures conservatively show groundwater that warrants a CMS, in that they are based on the maximum detections during multiple sampling events (for wells only). The concentrations used to derive the cumulative MCL values are presented for each SWMU in Tables A-1 through A-6.

A.2.1 Area A — Apron Area (SWMUs 7, 15, and 21)

Figures A-12, A-13, and A-14 illustrate the MCL exceedances for the upper, middle, and lower parts of the fluvial deposits identified during the SWMU 7, 15, and 21 RFIs. The exceedances are attributable mostly to chlorinated solvents and benzene. Each zone of the fluvial deposits is discussed below, along with the areas in which the most MCL exceedances were identified. Possible sources responsible for the contamination and a conceptual model of the contaminant plumes are discussed in Sections 4 and 5, respectively.

Upper Fluvial Deposits Groundwater

The primary groundwater contaminant beneath the west side of the Apron Area is benzene, which is attributed to the former fuel storage tanks at SWMU 15. Benzene concentrations in this area exceeded its 5 μg/L MCL at four locations ranging between 34 μg/L (well 015G02UF) and 4,600 μg/L (well 015G01UF). Chlorinated solvents at SWMU 15 were mostly absent in groundwater in the upper part of the fluvial deposits, as shown by a single TCE detection of 5μg/L at DPT location 7-47 (Figure A-12).

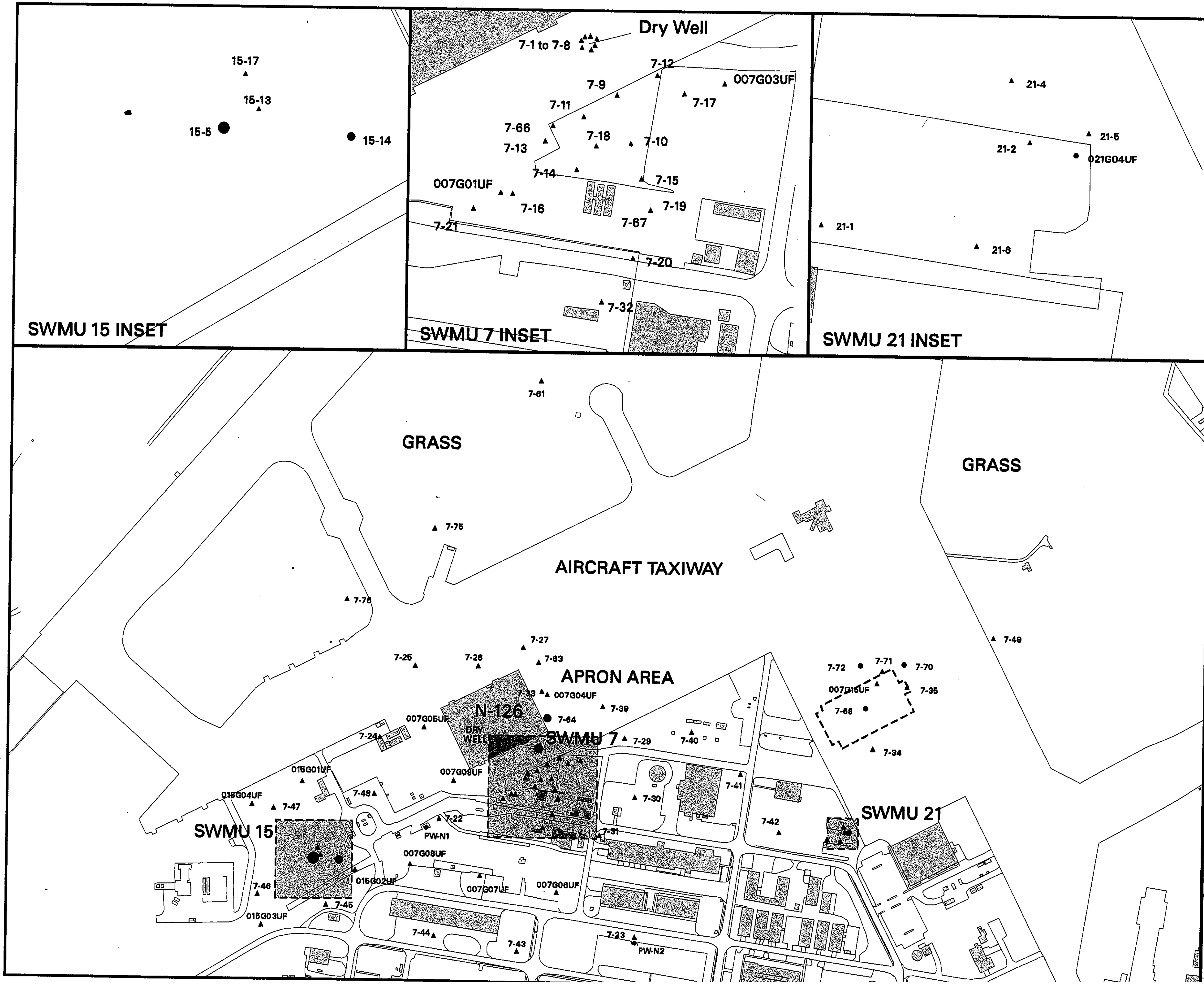
In the central portion of the Apron Area, TCE, 1,1-DCE and PCE are the primary VOCs exceeding their MCLs. Contamination was mostly identified south, southeast, and east of Building N-126. MCL exceedances were identified in three of nine upper fluvial deposits monitoring wells and 12 upper fluvial deposits DPT locations.

The east portion of the apron, north of SWMU 21, is shown as one of the more impacted areas (Figure A-12). Upper fluvial deposits well 007G15UF contained 840 μg/L TCE, 290 μg/L 1,1-DCE, 20 μg/L carbon tetrachloride, and 7 μg/L benzene. As discussed earlier in the report, this well is within the footprint of the former N-6 hangar, which housed operations that historically used solvents.

South of the former N-6 hangar, exceedances of the MCL for carbon tetrachloride were detected beneath SWMU 21. Concentrations equal to or exceeding the 5 μg/L MCL ranged from 5 to 163 μg/L. The inactive MAG-41 drum storage area, a speculated upgradient source area located south of SWMU 21, was investigated in December 1997 during the Gray Area Investigation. However, a source for the carbon tetrachloride was not identified during the investigation.

Middle Fluvial Deposits Groundwater

The most significant MCL exceedances in the middle part of the fluvial deposits are shown on Figure A-13 in the western and eastern sections of the Apron Area. A north-south oriented plume of TCE and 1,1-DCE was identified near the former N-6 hangar and north of it. TCE concentrations in this area ranged from 1,160 μg/L at location 7-69 to 26 μg/L at downgradient DPT location 7-80. TCE and PCE were also detected in excess of their MCLs in



LEGEND

INSETS FOR SWMU 7, 15 AND 2

PW-N1 PRODUCTION WELL SCREENED IN MEMPHIS AQUIFER

007G01UF FLUVIAL DEPOSITS MONITORING WELL

7-10 FLUVIAL DEPOSITS DPT SAMPLE

▲ CONTAMINANTS WERE NOT DETECTED OR NO SINGLE CONTAMINANT EXCEEDED THE MCL FOR DRINKING WATER

• CUMULATIVE MCL = 1-10 x MCL

● CUMULATIVE MCL = 10-100 x MCL

● CUMULATIVE MCL EXCEEDED = 100-1000 x MCL

● CUMULATIVE MCL > 1000 X MCL

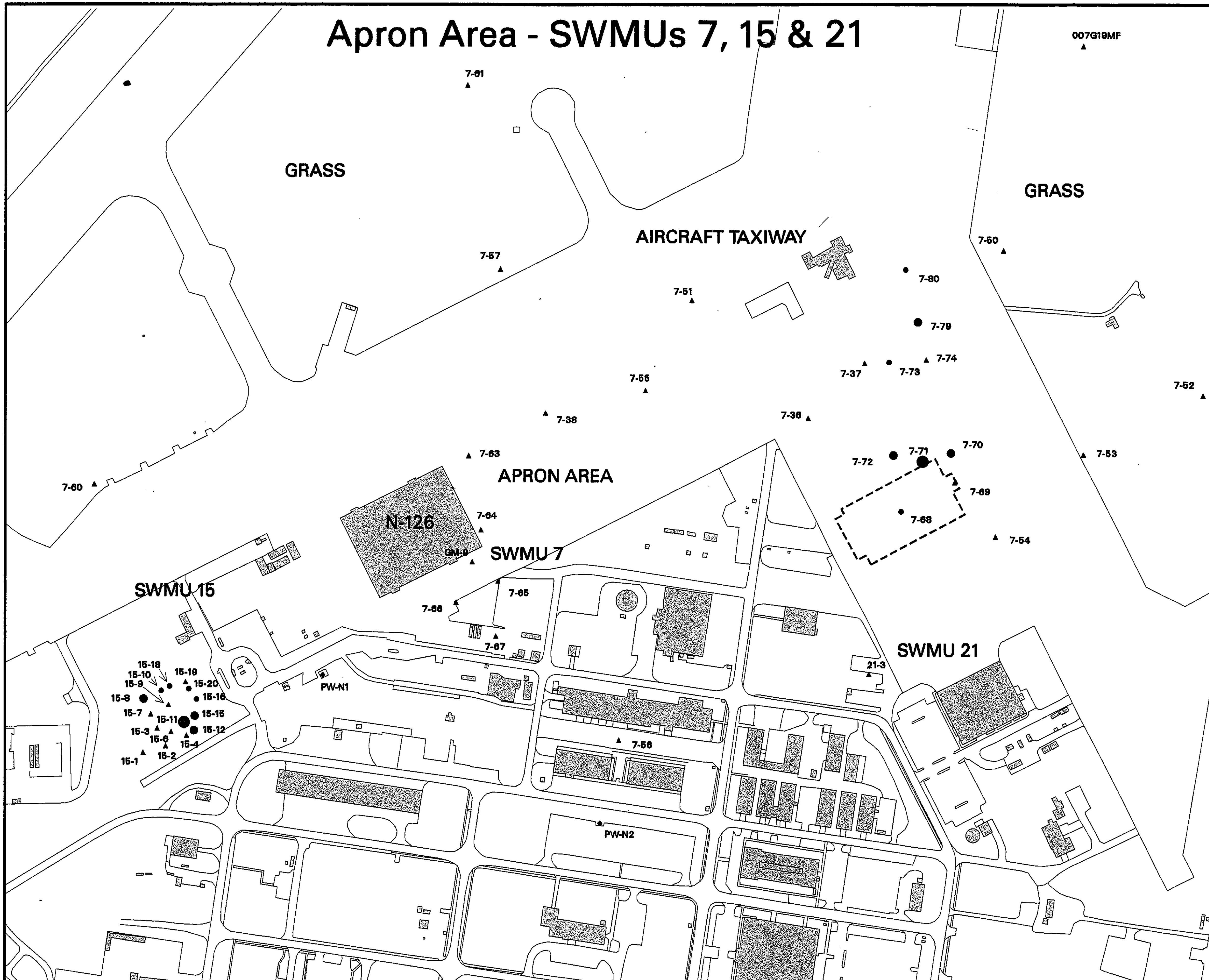
BASEMAP SCALE

0 feet 650

RCRA FACILITY INVESTIGATION
NAVAL SUPPORT ACTIVITY
MID-SOUTH
MILLINGTON, TN

FIGURE A-12
CUMULATIVE MCL EXCEEDANCES
AREA A - UPPER FLUVIAL DEPOSITS
GROUNDWATER

This page intentionally left blank.



LEGEND

INSETS FOR SWMU 15 AND 21

PW-N1 PRODUCTION WELL SCREENED IN MEMPHIS AQUIFER

007G19MF FLUVIAL DEPOSITS MONITORING WELL

7-10 FLUVIAL DEPOSITS DPT SAMPLE

▲ CONTAMINANTS WERE NOT DETECTED OR NO SINGLE CONTAMINANT EXCEEDED THE MCL FOR DRINKING WATER

● CUMULATIVE MCL = 1-10 x MCL

● CUMULATIVE MCL = 10-100 x MCL

● CUMULATIVE MCL EXCEEDED = 100-1000 x MCL

● CUMULATIVE MCL > 1000 X MCL

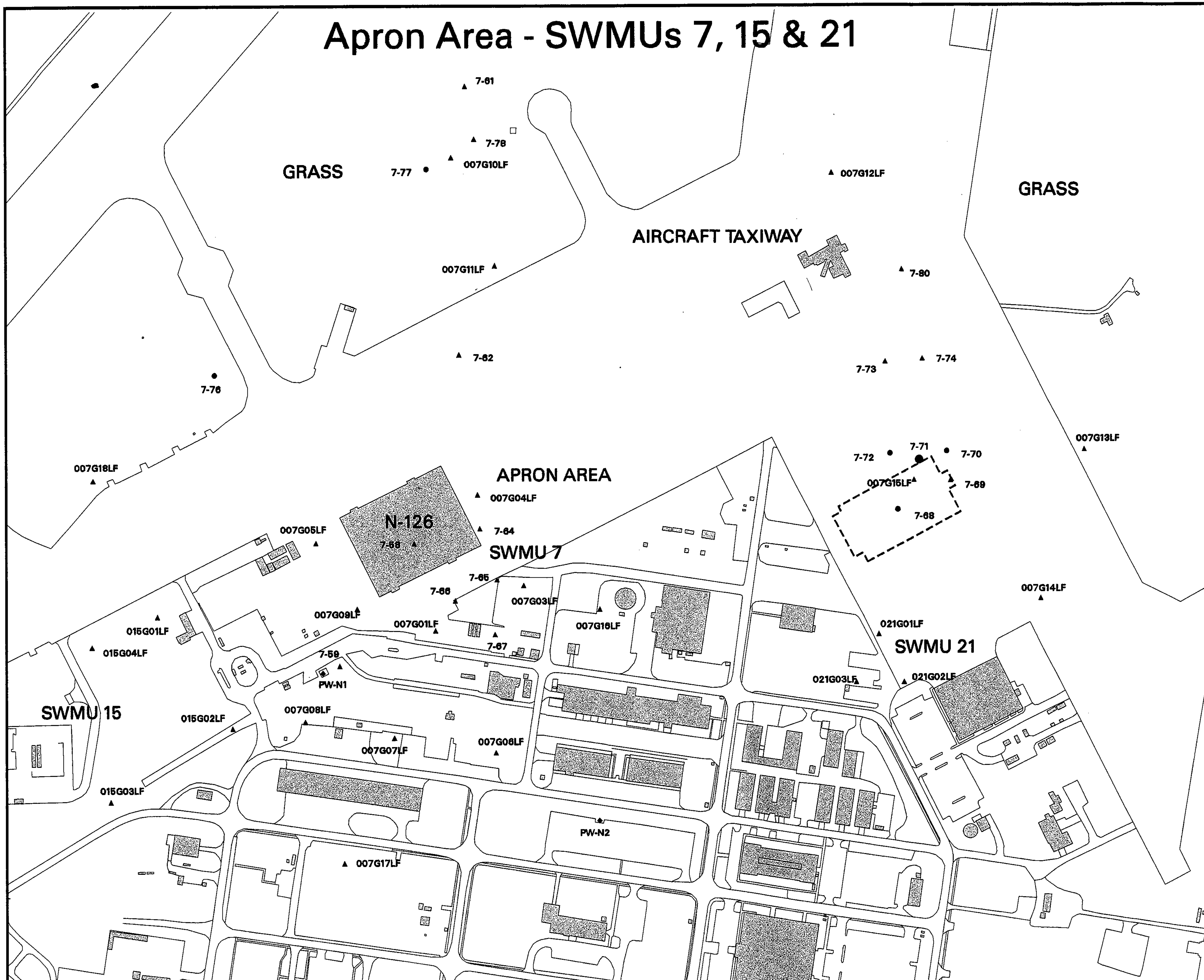
BASEMAP SCALE

0 feet 500

RCRA FACILITY INVESTIGATION
NAVAL SUPPORT ACTIVITY
MID-SOUTH
MILLINGTON, TN

FIGURE A-13
CUMULATIVE MCL EXCEEDANCES
AREA A - MIDDLE FLUVIAL DEPOSITS
GROUNDWATER

This page intentionally left blank.



RCRA FACILITY INVESTIGATION
NAVAL SUPPORT ACTIVITY
MID-SOUTH
MILLINGTON, TN

FIGURE A-14
CUMULATIVE MCL EXCEEDANCES
AREA A - LOWER FLUVIAL DEPOSITS
GROUNDWATER

This page intentionally left blank.

the middle fluvial deposits in the grassy area north of the taxiway (DPT location 7-57) and north of N-126, at 128 μg/L and 42.6 μg/L, respectively.

MCL exceedances associated with benzene were identified near the western section of the Apron Area at SWMU 15 where concentrations were detected at 8 DPT locations ranging between 9.7 μg/L (location 15-20) and 788 μg/L (location 15-11).

Lower Fluvial Deposits Groundwater

As shown in Figure A-14, MCL exceedances in the lower part of the fluvial deposits were present in a large portion of the Apron Area. TCE (high of 1,100 μg/L) and carbon tetrachloride (high of 20 μg/L) were the most widespread contaminants detected around Building N-126, with additional exceedances of PCE and 1,1-DCE. North of N-126, 653 μg/L benzene were detected at DPT location 7-62 and are thought to be the result of the former Aqua System that serviced planes with fuel while they were parked on the apron. MCL exceedances of PCE (high of 120 μg/L) and TCE (high of 230 μg/L) were detected in well 007G11LF, located in the grassy area north of the aircraft taxiway and N-126. Northwest of N-126, exceedances were attributed solely to TCE at DPT location 7-76 and well 007G18LF.

East of Building N-126, near the former N-6 hangar, there were fewer MCL exceedances of TCE and carbon tetrachloride and their spatial distribution was more limited than in the middle part of the fluvial deposits. The carbon tetrachloride detection that exceeded its MCL in the middle part of the fluvial deposits at SWMU 21 is absent in the lower part of the unit at the same SWMU location.

A.2.2 Area B — SWMUs 3 and 40

The only MCL exceedance in groundwater from the fluvial deposits in Area B was at SWMU 3, where a methylene chloride concentration of 36 μg/L (exceeding the 5 μg/L MCL) was detected in a single well (003G05MF). However, it was detected in only one of three sampling events, indicating that its presence is suspect. The SWMU 3 RFI report recommended no further action, which has been approved by the USEPA and TDEC (E/A&H, April 15, 1996).

A.2.3 Area C — SWMUs 5, 10, 27, and 60, and Background Location 5

SWMU 5 — As shown in Figure A-15, organic compounds that exceeded their MCLs in the fluvial deposits groundwater at SWMU 5 consisted of carbon tetrachloride (detected in upgradient wells 005G04AUF and 005G04BUF) and benzene (detected at DPT location 5-7). Cadmium exceeded its background RC (discussed previously in Section 4) and MCL of 5 μg/L. The cadmium detection was limited to one monitoring well — 005G02UF contained 5.4 μg/L. Lead was detected in one well (005G01UF) in concentrations exceeding its RC and the TTAL. No source of the carbon tetrachloride was identified during a subsequent groundwater in investigation at the southeast corner of the SWMU.

The source for the benzene detection (5.7 μg/L) in the groundwater sample from the upper fluvial deposits is likely from the overlying fuel contamination in the shallow soil and loess groundwater surrounding the former fire extinguisher pit north of Mat 305. Benzene was detected in loess groundwater at 3,900 μg/L (well FFMW-8; E/A&H, May 6, 1997). A separate CMS for the impacted loess soil and groundwater at this and other Northside SWMUs will address contaminants remaining in the loess. Corrective measures associated with the loess soil and groundwater will directly affect further leaching of contaminants into the fluvial deposits groundwater, thus allowing attenuation of existing benzene detected in the fluvial deposits groundwater. The carbon tetrachloride in the SWMU 5 fluvial deposits groundwater will be addressed in the AOC A CMS.

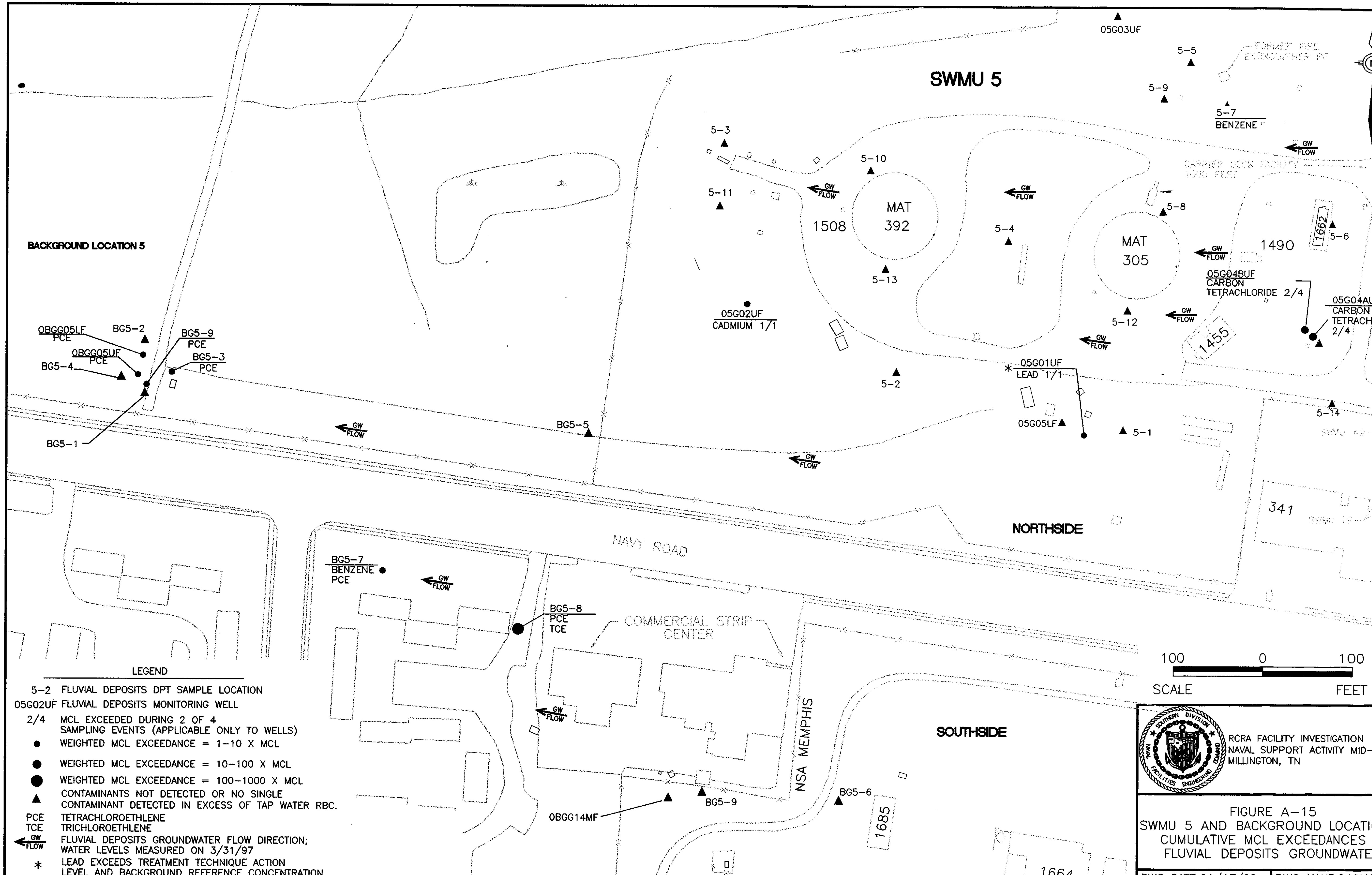


FIGURE A-15
SWMU 5 AND BACKGROUND LOCATION
CUMULATIVE MCL EXCEEDANCES –
FLUVIAL DEPOSITS GROUNDWATER

DWG DATE: 01/17/00 | DWG NAME: 94CMCLI

This page intentionally left blank.

SWMU 10 — Methylene chloride exceeded its 5 μg/L MCL (concentration of 6.2 μg/L) at DPT location 10-9. Methylene chloride was absent in the five other fluvial deposits samples collected using DPT methods, indicating it is limited spatially. Methylene chloride was also detected in the loess groundwater at similar concentrations at the same location. No further action was recommended in the CSI report (E/A&H, May 5, 1997). The USEPA and TDEC concurred with the recommendations presented in the CSI and have approved the final report.

SWMU 27 — No MCL exceedances were identified in the fluvial deposits groundwater at SWMU 27. No further action has been recommended in the CSI report which has been approved by the TDEC and USEPA (E/A&H, December 16, 1996).

SWMU 60 — No MCL exceedances were identified in the fluvial deposits groundwater at SWMU 60. The final RFI report (EnSafe, April 7, 1998) has been approved by the TDEC and USEPA.

A.2.4 Area D — North Fuel Farm

An MCL exceedance was identified in 1995 during the initial investigation at the North Fuel Farm. At this time, 6.8 μg/L of TCE were detected in one of two groundwater samples collected from the upper part of the fluvial deposits using DPT methods. However, its presence was not identified in a co-located sample or from 16 other locations sampled at the North Fuel Farm. No further action has been recommended for the fluvial deposits groundwater at the North Fuel Farm. The North Fuel Farm Investigation Technical Memorandum has been approved by the TDEC and USEPA (E/A&H, April 11, 1997).

A.2.5 Area E — SWMUs 1 and 62

No MCL exceedances were identified in the fluvial deposits groundwater at SWMUs 1 (E/A&H, March 19, 1997) and 62 (E/A&H, December 16, 1996). The final reports recommended no further action, both of which have been approved by the TDEC and USEPA.

A.2.6 Area F — SWMU 8

No MCL exceedances were identified in the fluvial deposits groundwater at SWMU 8 (E/A&H, December 6, 1997). The final report has been approved by the USEPA and TDEC.

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G01LF	1,1-Dichloroethane	810	DNE	ND	2.0 J	3.0 J	5.0 J	2.0 J	10.0 U	4/5	2.00 - 5.00	3.4	0.0	0.0
	1,1-Dichloroethene	0.044	7	ND	3.0 J	4.0 J	9.0 J	3.0 J	10.0 U	4/5	3.00 - 9.00	4.8	204.5	1.3
	1,2-Dichloroethene (total)	55	70	ND	2.0 J	2.0 J	2.0 J	2.0 J	10.0 U	4/5	2	2.6	0.0	0.0
	Barium	2,600	2,000	232	76.6 J	NS	NS	NS	NS	1/1	76.6	76.6	0.0	0.0
	Carbon tetrachloride	0.16	5	ND	4.0 J	10	10.0 U	6.0 J	10	4/5	4.00 - 10.00	7	62.5	2.0
	Chloroform	0.15	100	ND	2.0 J	2.0 J	10.0 U	2.0 J	10.0 U	3/5	2	3.2	13.3	0.0
	Cobalt	2,200	DNE	16.2	10.6 J	NS	NS	NS	NS	1/1	10.6	10.6	0.0	0.0
	Mercury (Hg)	11	2	0.25	0.2 J	NS	NS	NS	NS	1/1	0.21	0.2	0.0	0.1
	Trichloroethene	1.6	5	ND	6.0 J	8.0 J	4.0 J	8.0 J	10	5/5	4.00 - 10.00	7.2	6.3	2.0
	R Factor/Weighted MCL												***286.7***	***5.5***
007G01UF	1,1-Dichloroethane	810	DNE	ND	18	26	75	45	30	5/5	18.00 - 75.00	38.8	0.1	0.0
	1,1-Dichloroethene	0.044	7	ND	3.0 J	4.0 J	19	9.0 J	6.0 J	5/5	3.00 - 19.00	8.2	431.8	2.7
	1,2-Dichloroethene (total)	55	70	ND	5.0 J	6.0 J	14	10	6.0 J	5/5	5.00 - 14.00	8.2	0.3	0.2
	1,2-Dichloropropane	0.16	5	ND	10.0 U	10.0 U	2.0 J	2.0 J	10.0 U	2/5	2	3.8	12.5	0.4
	Barium	2,600	2,000	232	54.4 J	NS	NS	NS	NS	1/1	54.4	54.4	0.0	0.0
	Dibenzofuran	150	DNE	ND	10.0 U	NS	NS	NS	NS	1/1	10	10	0.1	0.0
	Lead	DNE	15 [a]	6.6	3.9	NS	NS	NS	NS	1/1	3.9	3.9	0.6	0.3
	Nickel	730	100	33.4	19.7 J	NS	NS	NS	NS	1/1	19.7	19.7	0.0	0.2
	Tetrachloroethene	1.1	5	ND	8.0 J	9.0 J	6.0 J	8.0 J	9.0 J	5/5	6.00 - 9.00	8	8.2	1.8
	Trichloroethene	1.6	5	ND	8.0 J	11	19	14	10	5/5	8.00 - 19.00	12.4	11.9	3.8
	Vanadium	260	DNE	17.4	7.1 J	NS	NS	NS	NS	1/1	7.1	7.1	0.0	0.0
	Zinc	11,000	DNE	39.8	56	NS	NS	NS	NS	1/1	56	56	0.0	0.0
	R Factor/Weighted MCL												***465.5***	***9.4***

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G03LF	1,2-Dichloroethane	0.12	5	ND	10.0 U	10.0 U	10.0 U	1.0 J	10.0 U	1/5	1	4.2	8.3	0.2
	2-Butanone (MEK)	1,900	DNE	ND	10.0 UJ	10.0 U	10.0 U	20.0 J	10.0 U	1/5	20	8	0.0	0.0
	Acetone	3,700	DNE	ND	78	10.0 U	10.0 U	10.0 UJ	10.0 U	1/5	78	19.6	0.0	0.0
	Barium	2,600	2,000	232	86.1 J	NS	NS	NS	NS	1/1	86.1	86.1	0.0	0.0
	Carbon tetrachloride	0.16	5	ND	12	16	19	20.0 J	19	5/5	12.00 - 20.00	17.2	125.0	4.0
	Chloroform	0.15	100	ND	8.0 J	8.0 J	10	11	10	5/5	8.00 - 11.00	9.4	73.3	0.1
	Cobalt	2,200	DNE	16.2	6.5 J	NS	NS	NS	NS	1/1	6.5	6.5	0.0	0.0
	Tetrachloroethene	1.1	5	ND	1.0 J	2.0 J	2.0 J	4.0 J	3.0 J	5/5	1.00 - 4.00	2.4	3.6	0.8
	Trichloroethene	1.6	5	ND	63	73	98	97	78	5/5	63.00 - 98.00	81.8	61.3	19.6
	R Factor/Weighted MCL												***271.6***	***24.8***
007G03UF	Acetone	3,700	DNE	ND	12	39	5.0 U	10.0 UJ	10.0 U	2/5	12.00 - 39.00	12.7	0.0	0.0
	Carbon disulfide	1,000	DNE	ND	10.0 U	3.0 J	10.0 U	10.0 U	10.0 U	1/5	3	4.6	0.0	0.0
	R Factor/Weighted MCL												0.0	0.0
007G04LF	1,1-Dichloroethene	0.044	7	ND	10.0 U	50.0 U	2.0 J	10.0 U	2.0 J	2/5	2	7.8	45.5	0.3
	1,2-Dichloroethene (total)	55	70	ND	10.0 U	50.0 U	2.0 J	10.0 UJ	2.0 J	2/5	2	7.8	0.0	0.0
	Acetone	3,700	DNE	ND	83	50.0 U	95.0 J	10.0 UJ	10.0 U	2/5	83.00 - 95.00	42.6	0.0	0.0
	Barium	2,600	2,000	232	130.0 J	NS	NS	NS	NS	1/1	130	130	0.1	0.1
	Carbon tetrachloride	0.16	5	ND	10.0 U	9.0 J	10.0 U	13.0 J	9.0 J	3/5	9.00 - 13.00	8.2	81.3	2.6
	Chloroform	0.15	100	ND	10.0 U	50.0 U	10.0 U	3.0 J	2.0 J	2/5	2.00 - 3.00	8	20.0	0.0
	Chromium	180	100	39.8	13.1	NS	NS	NS	NS	1/1	13.1	13.1	0.1	0.1
	Cobalt	2,200	DNE	16.2	5.8 J	NS	NS	NS	NS	1/1	5.8	5.8	0.0	0.0
	Copper	1,500	1,300	5.6	17.4 J	NS	NS	NS	NS	1/1	17.4	17.4	0.0	0.0
	Lead	DNE	15 [a]	6.6	7.6	NS	NS	NS	NS	1/1	7.6	7.6	1.2	0.5

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G04LF (continued)	Methylene chloride	4.1	5	ND	10.0 U	50.0 U	1.0 J	10.0 U	10.0 U	1/5	1	8.2	0.2	0.2
	Tetrachloroethene	1.1	5	ND	10.0 U	26.0 J	61	6.0 J	31	4/5	6.00 - 61.00	25.8	55.5	12.2
	Trichloroethene	1.6	5	ND	2.0 J	390	1100.0 D	160	620.0 D	5/5	2.00 - 1100.00	454.4	687.5	220.0
	Zinc	11,000	DNE	39.8	367	NS	NS	NS	NS	1/1	367	367	0.0	0.0
	R Factor/Weighted MCL												***891.3***	***236.1***
007G04UF	Acetone	3,700	DNE	ND	30	18.0 J	240	10.0 UJ	10.0 U	3/5	18.00 - 240.00	59.6	0.1	0.0
	Barium	2,600	2,000	232	20.7 J	NS	NS	NS	NS	1/1	20.7	20.7	0.0	0.0
	Chromium	180	100	39.8	6.0 J	NS	NS	NS	NS	1/1	6	6	0.0	0.1
	Lead	DNE	15 [a]	6.6	2.0 J	NS	NS	NS	NS	1/1	2	2	0.3	0.1
	Methylene chloride	4.1	5	ND	10.0 U	10.0 U	2.0 J	10.0 U	10.0 U	1/5	2	4.4	0.5	0.4
	Trichloroethene	1.6	5	ND	3.0 J	1.0 J	20.0 U	10.0 U	10.0 U	2/5	1.00 - 3.00	4.8	1.9	0.6
	R Factor/Weighted MCL												***2.8***	***1.2***
007G05LF	1,2-Dichloroethane	0.12	5	ND	4.0 J	4.0 J	4.0 J	10.0 U	3.0 J	4/5	3.00 - 4.00	4	33.3	0.8
	Acetone	3,700	DNE	ND	10.0 U	11.0 J	10.0 U	10.0 U	10.0 UJ	1/5	11	6.2	0.0	0.0
	Barium	2,600	2,000	232	76.7 J	NS	NS	NS	NS	1/1	76.7	76.7	0.0	0.0
	Carbon tetrachloride	0.16	5	ND	6.0 J	8.0 J	7.0 J	11	6.0 J	5/5	6.00 - 11.00	7.6	68.8	2.2
	Chloroform	0.15	100	ND	4.0 J	5.0 J	10.0 U	5.0 J	4.0 J	4/5	4.00 - 5.00	4.6	33.3	0.1
	Mercury (Hg)	11	2	0.25	0.2 J	NS	NS	NS	NS	1/1	0.2	0.2	0.0	0.1
	Tetrachloroethene	1.1	5	ND	10.0 U	1.0 J	1.0 J	1.0 J	1.0 J	4/5	1	1.8	0.9	0.2
	Trichloroethene	1.6	5	ND	22	28	31	38	27.0 J	5/5	22.00 - 38.00	29.2	23.8	7.6
	R Factor/Weighted MCL												***160.1***	***11.0***

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G05UF	2-Butanone (MEK)	1,900	DNE	ND	10.0 U	10.0 U	1.0 J	10.0 UJ	10.0 U	1/5	1	4.2	0.0	0.0
	Acetone	3,700	DNE	ND	10.0 U	98	39.0 U	10.0 UJ	10.0 U	1/5	98	26.5	0.0	0.0
	Barium	2,600	2,000	232	120.0 J	NS	NS	NS	NS	1/1	120	120	0.1	0.1
	Chromium	180	100	39.8	79.8	NS	NS	NS	NS	1/1	79.8	79.8	0.4	0.8
	Cobalt	2,200	DNE	16.2	5.5 J	NS	NS	NS	NS	1/1	5.5	5.5	0.0	0.0
	Copper	1,500	1,300	5.6	15.1 J	NS	NS	NS	NS	1/1	15.1	15.1	0.0	0.0
	Lead	DNE	15 [a]	6.6	10.2	NS	NS	NS	NS	1/1	10.2	10.2	1.6	0.7
	Mercury (Hg)	11	2	0.25	0.4 J	NS	NS	NS	NS	1/1	0.35	0.4	0.0	0.2
	Nickel	730	100	33.4	59.3	NS	NS	NS	NS	1/1	59.3	59.3	0.1	0.6
	Vanadium	260	DNE	17.4	44.8 J	NS	NS	NS	NS	1/1	44.8	44.8	0.2	0.0
	Zinc	11,000	DNE	39.8	28.4	NS	NS	NS	NS	1/1	28.4	28.4	0.0	0.0
	R Factor/Weighted MCL												***2.4***	***2.3***
007G06LF	Acetone	3,700	DNE	ND	5.0 J	5.0 J	51.0 UJ	10.0 UJ	10.0 U	2/5	5	9.1	0.0	0.0
	Barium	2,600	2,000	232	122.0 J	NS	NS	NS	NS	1/1	122	122	0.1	0.1
	Cobalt	2,200	DNE	16.2	6.6 J	NS	NS	NS	NS	1/1	6.6	6.6	0.0	0.0
	Lead	DNE	15 [a]	6.6	2.0 J	NS	NS	NS	NS	1/1	2	2	0.3	0.1
	Tetrachloroethene	1.1	5	ND	1.0 J	1.0 J	2.0 J	2.0 J	3.0 J	5/5	1.00 - 3.00	1.8	2.7	0.6
	Trichloroethene	1.6	5	ND	2.0 J	2.0 J	2.0 J	2.0 J	3.0 J	5/5	2.00 - 3.00	2.2	1.9	0.6
	R Factor/Weighted MCL												***5.0***	***1.4***
007G06UF	Acetone	3,700	DNE	ND	59	320	10.0 U	10.0 U	10.0 U	2/5	59.00 - 320.00	78.8	0.1	0.0
	Barium	2,600	2,000	232	43.8 J	NS	NS	NS	NS	1/1	43.8	43.8	0.0	0.0
	Chromium	180	100	39.8	5.0 J	NS	NS	NS	NS	1/1	5	5	0.0	0.1

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G06UF (continued)	Cobalt	2,200	DNE	16.2	5.9 J	NS	NS	NS	NS	1/1	5.9	5.9	0.0	0.0
	Mercury (Hg)	11	2	0.25	0.2	NS	NS	NS	NS	1/1	0.22	0.2	0.0	0.1
	R Factor/Weighted MCL												***0.2***	***0.2***
007G07LF	1,1-Dichloroethane	810	DNE	ND	2.0 J	1.0 J	NS	10.0 U	10.0 U	2/4	1.00 - 2.00	3.3	0.0	0.0
	1,1-Dichloroethene	0.044	7	ND	1.0 J	1.0 J	NS	10.0 U	10.0 U	2/4	1	3	22.7	0.1
	Acetone	3,700	DNE	ND	33	10.0 UJ	NS	10.0 U	10.0 U	1/4	33	12	0.0	0.0
	Barium	2,600	2,000	232	160.0 J	NS	NS	NS	NS	1/1	160	160	0.1	0.1
	Carbon disulfide	1,000	DNE	ND	1.0 J	10.0 U	NS	10.0 U	10.0 U	1/4	1	4	0.0	0.0
	Carbon tetrachloride	0.16	5	ND	10.0 U	1.0 J	NS	10.0 U	10.0 U	1/4	1	4	6.3	0.2
	Chromium	180	100	39.8	6.9 J	NS	NS	NS	NS	1/1	6.9	6.9	0.0	0.1
	Cobalt	2,200	DNE	16.2	18.4 J	NS	NS	NS	NS	1/1	18.4	18.4	0.0	0.0
	Copper	1,500	1,300	5.6	5.3 J	NS	NS	NS	NS	1/1	5.3	5.3	0.0	0.0
	Mercury (Hg)	11	2	0.25	0.3	NS	NS	NS	NS	1/1	0.28	0.3	0.0	0.1
	Tetrachloroethene	1.1	5	ND	3.0 J	3.0 J	NS	8.0 J	6.0 J	4/4	3.00 - 8.00	5	7.3	1.6
	Trichloroethene	1.6	5	ND	6.0 J	6.0 J	NS	7.0 J	6.0 J	4/4	6.00 - 7.00	6.3	4.4	1.4
	R Factor/Weighted MCL												***40.8***	***3.6***
007G07UF	Acetone	3,700	DNE	ND	10.0 U	25.0 J	10.0 U	10.0 U	10.0 U	1/5	25	9	0.0	0.0
	Barium	2,600	2,000	232	76.3 J	NS	NS	NS	NS	1/1	76.3	76.3	0.0	0.0
	Chromium	180	100	39.8	6.4 J	NS	NS	NS	NS	1/1	6.4	6.4	0.0	0.1
	Lead	DNE	15 [a]	6.6	2.4 J	NS	NS	NS	NS	1/1	2.4	2.4	0.4	0.2
	Mercury (Hg)	11	2	0.25	0.2	NS	NS	NS	NS	1/1	0.2	0.2	0.0	0.1
	Vinyl chloride	0.019	2	ND	2.0 J	2.0 J	10.0 U	10.0 U	10.0 U	2/5	2	3.8	105.3	1.0

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G08LF	BEHP	4.8	DNE	ND	1.0 J	NS	NS	NS	NS	1/1	1	1	0.2	0.0
	R Factor/Weighted MCL												***105.9***	***1.4***
	1,1-Dichloroethane	810	DNE	ND	4.0 J	4.0 J	100.0 U	5.0 J	10.0 U	3/5	4.00 - 5.00	13.6	0.0	0.0
	1,1-Dichloroethene	0.044	7	ND	7.0 J	6.0 J	100.0 U	9.0 J	10	4/5	6.00 - 10.00	16.4	227.3	1.4
	1,2-Dichloroethene (total)	55	70	ND	2.0 J	1.0 J	100.0 U	2.0 J	10.0 U	3/5	1.00 - 2.00	12	0.0	0.0
	Acetone	3,700	DNE	ND	10.0 U	10.0 UJ	1,200	10.0 U	10.0 U	1/5	1,200	244	0.3	0.0
	Barium	2,600	2,000	232	80.5 J	NS	NS	NS	NS	1/1	80.5	80.5	0.0	0.0
	Cobalt	2,200	DNE	16.2	6.1 J	NS	NS	NS	NS	1/1	6.1	6.1	0.0	0.0
	Copper	1,500	1,300	5.6	5.0 J	NS	NS	NS	NS	1/1	5	5	0.0	0.0
	Trichloroethene	1.6	5	ND	7.0 J	8.0 J	100.0 U	9.0 J	9.0 J	4/5	7.00 - 9.00	16.6	5.6	1.8
	Zinc	11,000	DNE	39.8	65	NS	NS	NS	NS	1/1	65	65	0.0	0.0
	R Factor/Weighted MCL												***233.3***	***3.3***
007G08UF	1,2-Dichloroethane	0.12	5	ND	3.0 J	3.0 J	2.0 J	10.0 U	10.0 U	3/5	2.00 - 3.00	3.6	25.0	0.6
	Barium	2,600	2,000	232	50.1 J	NS	NS	NS	NS	1/1	50.1	50.1	0.0	0.0
	Trichloroethene	1.6	5	ND	1.0 J	1.0 J	10.0 U	2.0 J	10.0 U	3/5	1.00 - 2.00	2.8	1.3	0.4
	R Factor/Weighted MCL												***26.3***	***1.0***
007G09LF	1,1-Dichloroethane	810	DNE	ND	10.0 U	10.0 U	2.0 J	10.0 U	2.0 J	2/5	2	3.8	0.0	0.0
	1,1-Dichloroethene	0.044	7	ND	10.0 U	10.0 U	1.0 J	10.0 U	10.0 U	1/5	1	4.2	22.7	0.1
	1,2-Dichloroethane	0.12	5	ND	10.0 U	2.0 J	10.0 U	10.0 U	10.0 U	1/5	2	4.4	16.7	0.4
	1,2-Dichloroethene (total)	55	70	ND	10.0 U	10	34	16	40	4/5	10.00 - 40.00	21	0.7	0.6
	Barium	2,600	2,000	232	105.0 J	NS	NS	NS	NS	1/1	105	105	0.0	0.1
	Benzene	0.36	5	ND	10.0 U	10.0 U	2.0 J	10.0 U	10.0 U	1/5	2	4.4	5.6	0.4
	Chloroform	0.15	100	ND	10.0 U	2.0 J	1.0 J	10.0 U	10.0 U	2/5	1.00 - 2.00	3.6	13.3	0.0

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G09LF (continued)	Cobalt	2,200	DNE	16.2	6.6 J	NS	NS	NS	NS	1/1	6.6	6.6	0.0	0.0
	Tetrachloroethene	1.1	5	ND	10.0 U	6.0 J	15	12	33	4/5	6.00 - 33.00	14.2	30.0	6.6
	Trichloroethene	1.6	5	ND	10.0 U	4.0 J	4.0 J	4.0 J	8.0 J	4/5	4.00 - 8.00	5	5.0	1.6
	Xylene (Total)	12,000	10,000	ND	10.0 U	10.0 U	3.0 J	10.0 U	10.0 U	1/5	3	4.6	0.0	0.0
	R Factor/Weighted MCL												***94.1***	***9.8***
007G09UF	1,1-Dichloroethane	810	DNE	ND	1.0 J	10.0 U	NS	10.0 UJ	10.0 U	1/4	1	4	0.0	0.0
	Acetone	3,700	DNE	ND	26	10.0 UJ	NS	10.0 UJ	10.0 U	1/4	26	10.3	0.0	0.0
	Barium	2,600	2,000	232	46.5 J	NS	NS	NS	NS	1/1	46.5	46.5	0.0	0.0
	Bromomethane	8.7	DNE	ND	1.0 J	10.0 U	NS	10.0 UJ	10.0 U	1/4	1	4	0.1	0.0
	Cobalt	2,200	DNE	16.2	7.7 J	NS	NS	NS	NS	1/1	7.7	7.7	0.0	0.0
	Copper	1,500	1,300	5.6	5.0 J	NS	NS	NS	NS	1/1	5	5	0.0	0.0
	R Factor/Weighted MCL												***0.2***	***0.0***
0GMG09MF GM-9	1,1-Dichloroethene	0.044	7	ND	5.0 U	1.0 J	10.0 U	NS	NS	1/3	1	2.8	22.7	0.1
	2-Butanone (MEK)	1,900	DNE	ND	10.0 U	10.0 U	19	NS	NS	1/3	19	9.7	0.0	0.0
	Barium	2,600	2,000	232	39.8 J	NS	NS	NS	NS	1/1	39.8	39.8	0.0	0.0
	Benzene	0.36	5	ND	5.0 U	10.0 U	10.0 U	NS	NS	0/3		5	0.0	0.0
	Lead	DNE	15[a]	6.6	2.3 J	NS	NS	NS	NS	1/1	2.3	2.3	0.4	0.2
	Toluene	750	1,000	ND	5.0 U	10.0 U	10.0 U	NS	NS	0/3	0	3.4	0.0	0.0
	Trichloroethene	1.6	5	ND	7.3	7.0 J	4.0 J	NS	NS	3/3	4.00 - 7.30	4.6	4.6	1.5
	R Factor/Weighted MCL												***27.7***	***1.8***

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results ($\mu g/L$) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G10LF	4-Methyl-2-Pentanone (MIBK)	2,900	DNE	ND	NS	NS	NS	2.0 J	10.0 U	1/2	2	3.5	0.0	0.0
	Barium	2,600	2,000	232	NS	NS	NS	238	NS	1/1	238	238	0.1	0.1
	Carbon tetrachloride	0.16	5	ND	NS	NS	NS	12	11	2/2	11.00 - 12.00	11.5	75.0	2.4
	Chloroform	0.15	100	ND	NS	NS	NS	9.0 J	6.0 J	2/2	6.00 - 9.00	7.5	60.0	0.1
	Chromium	180	100	39.8	NS	NS	NS	9.4 J	NS	1/1	9.4	9.4	0.1	0.1
	Cobalt	2,200	DNE	16.2	NS	NS	NS	10.3 J	NS	1/1	10.3	10.3	0.0	0.0
	Lead	DNE	15 [a]	6.6	NS	NS	NS	2.7 J	NS	1/1	2.7	2.7	0.4	0.2
	Tetrachloroethene	1.1	5	ND	NS	NS	NS	9.0 J	8.0 J	2/2	8.00 - 9.00	8.5	8.2	1.8
	Trichloroethene	1.6	5	ND	NS	NS	NS	16	15	2/2	15.00 - 16.00	15.5	10.0	3.2
	Zinc	11,000	DNE	39.8	NS	NS	NS	14.8 J	NS	1/1	14.8	14.8	0.0	0.0
	R Factor/Weighted MCL												*153.7*	*7.9*
007G11LF	1,2-Dichloroethene (total)	55	70	ND	NS	NS	NS	3.0 J	10.0 U	1/2	3	4	0.1	0.0
	Barium	2,600	2,000	232	NS	NS	NS	204	NS	1/1	204	204	0.1	0.1
	Carbon tetrachloride	0.16	5	ND	NS	NS	NS	6.0 J	10.0 U	1/2	6	5.5	37.5	1.2
	Chloroform	0.15	100	ND	NS	NS	NS	11	8.0 J	2/2	8.00 - 11.00	9.5	73.3	0.1
	Chromium	180	100	39.8	NS	NS	NS	10.1	NS	1/1	10.1	10.1	0.1	0.1
	TPH - Diesel Range Organics	100	DNE	ND	NS	NS	NS	150	NS	1/1	150	150	1.5	0.0
	Tetrachloroethene	1.1	5	ND	NS	NS	NS	120	27	2/2	27.00 - 120.00	73.5	109.1	24.0
	Trichloroethene	1.6	5	ND	NS	NS	NS	230.0 D	57	2/2	57.00 - 230.00	143.5	143.8	46.0
	R Factor/Weighted MCL												*365.4*	*71.6*

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G12LF	Barium	2,600	2,000	232	NS	NS	NS	40.2 J	NS	1/1	40.2	40.2	0.0	0.0
	Chromium	180	100	39.8	NS	NS	NS	92.5 J	NS	1/1	92.5	92.5	0.5	0.9
	Cobalt	2,200	DNE	16.2	NS	NS	NS	6.2 J	NS	1/1	6.2	6.2	0.0	0.0
	Lead	DNE	15 [a]	6.6	NS	NS	NS	3.5 J	NS	1/1	3.5	3.5	0.5	0.2
	Nickel	730	100	33.4	NS	NS	NS	55.4 J	NS	1/1	55.4	55.4	0.1	0.6
	Vanadium	260	DNE	17.4	NS	NS	NS	5.3 J	NS	1/1	5.3	5.3	0.0	0.0
	Zinc	11,000	DNE	39.8	NS	NS	NS	10.2 J	NS	1/1	10.2	10.2	0.0	0.0
	R Factor/Weighted MCL												***1.2***	***1.7***
007G13LF	Arsenic	3.5	50	3.5	NS	NS	NS	10.5	NS	1/1	10.5	10.5	3.0	0.2
	Barium	2,600	2,000	232	NS	NS	NS	103.0 J	NS	1/1	103	103	0.0	0.1
	Chromium	180	100	39.8	NS	NS	NS	22.2	NS	1/1	22.2	22.2	0.1	0.2
	Lead	DNE	15 [a]	6.6	NS	NS	NS	3.0 J	NS	1/1	3	3	0.5	0.2
	Vanadium	260	DNE	17.4	NS	NS	NS	11.3 J	NS	1/1	11.3	11.3	0.0	0.0
	BEHP	4.8	DNE	ND	NS	NS	NS	2.0 J	NS	1/1	2	2	0.4	0.0
	R Factor/Weighted MCL												***4.1***	***0.7***
007G14LF	Barium	2,600	2,000	232	NS	NS	NS	75.4 J	NS	1/1	75.4	75.4	0.0	0.0
	Chromium	180	100	39.8	NS	NS	NS	13.3	NS	1/1	13.3	13.3	0.1	0.1
	Cobalt	2,200	DNE	16.2	NS	NS	NS	5.8 J	NS	1/1	5.8	5.8	0.0	0.0
	Lead	DNE	15 [a]	6.6	NS	NS	NS	3.1	NS	1/1	3.1	3.1	0.5	0.2
	Vanadium	260	DNE	17.4	NS	NS	NS	18.2 J	NS	1/1	18.2	18.2	0.1	0.0
	Zinc	11,000	DNE	39.8	NS	NS	NS	47.9	NS	1/1	47.9	47.9	0.0	0.0
	BEHP	4.8	DNE	ND	NS	NS	NS	8.0 J	NS	1/1	8	8	1.7	0.0
	R Factor/Weighted MCL												***2.3***	***0.4***

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G15LF	1,1-Dichloroethane	810	DNE	ND	NS	NS	NS	10.0 U	2.0 J	1/2	2	3.5	0.0	0.0
	1,1-Dichloroethene	0.044	7	ND	NS	NS	NS	10.0 U	6.0 J	1/2	6	5.5	136.4	0.9
	Arsenic	3.5	50	3.5	NS	NS	NS	7.9 J	NS	1/1	7.9	7.9	2.3	0.2
	Barium	2,600	2,000	232	NS	NS	NS	171.0 J	NS	1/1	171	171	0.1	0.1
	Carbon tetrachloride	0.16	5	ND	NS	NS	NS	20	26	2/2	20.00 - 26.00	23	162.5	5.2
	Chloroform	0.15	100	ND	NS	NS	NS	5.0 J	10	2/2	5.00 - 10.00	7.5	66.7	0.1
	Chromium	180	100	39.8	NS	NS	NS	59.6	NS	1/1	59.6	59.6	0.3	0.6
	Cobalt	2,200	DNE	16.2	NS	NS	NS	16.2 J	NS	1/1	16.2	16.2	0.0	0.0
	Lead	DNE	15 [a]	6.6	NS	NS	NS	29.2	NS	1/1	29.2	29.2	4.4	2.0
	Mercury	11	2	0.25	NS	NS	NS	0.3	NS	1/1	0.32	0.3	0.0	0.2
	Nickel	730	100	33.4	NS	NS	NS	33.7 J	NS	1/1	33.7	33.7	0.1	0.3
	TPH - Diesel Range Organics	100	DNE	ND	NS	NS	NS	110	NS	1/1	110	110	1.1	0.0
	Tin	22,000	DNE	ND	NS	NS	NS	59.0 J	NS	1/1	59	59	0.0	0.0
	Trichloroethene	1.6	5	ND	NS	NS	NS	10.0 U	13	1/2	13	9	8.1	2.6
	Vanadium	260	DNE	17.4	NS	NS	NS	52.6	NS	1/1	52.6	52.6	0.2	0.0
	Zinc	11,000	DNE	39.8	NS	NS	NS	237	NS	1/1	237	237	0.0	0.0
	BEHP	4.8	DNE	ND	NS	NS	NS	14	NS	1/1	14	14	2.9	0.0
	R Factor/Weighted MCL												***385.1***	***12.0***
007G15UF	1,1-Dichloroethane	810	DNE	ND	NS	NS	NS	48.0 J	43.0 J	2/2	43.00 - 48.00	45.5	0.1	0.0
	1,1-Dichloroethene	0.044	7	ND	NS	NS	NS	280	290	2/2	280.00 - 290.00	285	6,590.9	41.4
	1,2-Dichloroethene (total)	55	70	ND	NS	NS	NS	20.0 J	22.0 J	2/2	20.00 - 22.00	21	0.4	0.3

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G15UF (continued)	Barium	2,600	2,000	232	NS	NS	NS	124.0 J	NS	1/1	124	124	0.1	0.1
	Benzene	0.36	5	ND	NS	NS	NS	7.0 J	6.0 J	2/2	6.00 - 7.00	6.5	19.4	1.4
	Carbon tetrachloride	0.16	5	ND	NS	NS	NS	20.0 J	19.0 J	2/2	19.00 - 20.00	19.5	125.0	4.0
	Chloroform	0.15	100	ND	NS	NS	NS	70	63	2/2	63.00 - 70.00	66.5	466.7	0.7
	Cobalt	2,200	DNE	16.2	NS	NS	NS	14.4 J	NS	1/1	14.4	14.4	0.0	0.0
	TPH - Diesel Range Organics	100	DNE	ND	NS	NS	NS	160	NS	1/1	160	160	1.6	0.0
	Trichloroethene	1.6	5	ND	NS	NS	NS	840	800	2/2	800.00 - 840.00	820	525.0	168.0
	BEHP	4.8	DNE	ND	NS	NS	NS	1.0 J	NS	1/1	1	1	0.2	0.0
	R Factor/Weighted MCL												***7,729.3***	***215.9***
007G16LF	Barium	2,600	2,000	232	NS	NS	NS	82.1 J	NS	1/1	82.1	82.1	0.0	0.0
	Cadmium	18	5	3.9	NS	NS	NS	3.8 J	NS	1/1	3.8	3.8	0.2	0.8
	Carbon tetrachloride	0.16	5	ND	NS	NS	NS	27	30	2/2	27.00 - 30.00	28.5	187.5	6.0
	Chloroform	0.15	100	ND	NS	NS	NS	8.0 J	5.0 J	2/2	5.00 - 8.00	6.5	53.3	0.1
	Cobalt	2,200	DNE	16.2	NS	NS	NS	10.9 J	NS	1/1	10.9	10.9	0.0	0.0
	Trichloroethene	1.6	5	ND	NS	NS	NS	7.0 J	10	2/2	7.00 - 10.00	8.5	6.3	2.0
	BEHP	4.8	DNE	ND	NS	NS	NS	1.0 J	NS	1/1	1	1	0.2	0.0
	R Factor/Weighted MCL												***247.5***	***8.9***
007G17LF	Acetone	3,700	DNE	ND	NS	NS	NS	7.0 J	10.0 U	1/2	7	6	0.0	0.0
	Barium	2,600	2,000	232	NS	NS	NS	172.0 J	NS	1/1	172	172	0.1	0.1
	Chromium	180	100	39.8	NS	NS	NS	47.3	NS	1/1	47.3	47.3	0.3	0.5

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G17LF (continued)	Cobalt	2,200	DNE	16.2	NS	NS	NS	20.4 J	NS	1/1	20.4	20.4	0.0	0.0
	Lead	DNE	15 [a]	6.6	NS	NS	NS	7.5	NS	1/1	7.5	7.5	1.1	0.5
	Nickel	730	100	33.4	NS	NS	NS	27.4 J	NS	1/1	27.4	27.4	0.0	0.3
	Vanadium	260	DNE	17.4	NS	NS	NS	15.0 J	NS	1/1	15	15	0.1	0.0
	Zinc	11,000	DNE	39.8	NS	NS	NS	278	NS	1/1	278	278	0.0	0.0
	R Factor/Weighted MCL												***1.6***	***1.3***
007G18LF	4-Methyl-2-Pentanone (MIBK)	2,900	DNE	ND	NS	NS	NS	10.0 U	1.0 J	1/2	1	3	0.0	0.0
	Barium	2,600	2,000	232	NS	NS	NS	99.7 J	NS	1/1	99.7	99.7	0.0	0.1
	Carbon tetrachloride	0.16	5	ND	NS	NS	NS	1.0 J	1.0 J	2/2	1	1	6.3	0.2
	Chloroform	0.15	100	ND	NS	NS	NS	2.0 J	2.0 J	2/2	2	2	13.3	0.0
	Chromium	180	100	39.8	NS	NS	NS	8.6 J	NS	1/1	8.6	8.6	0.1	0.1
	Tetrachloroethene	1.1	5	ND	NS	NS	NS	1.0 J	10.0 U	1/2	1	3	0.9	0.2
	Trichloroethene	1.6	5	ND	NS	NS	NS	8.0 J	6.0 J	2/2	6.00 - 8.00	7	5.0	1.6
	BEHP	4.8	DNE	ND	NS	NS	NS	1.0 J	NS	1/1	1	1	0.2	0.0
	R Factor/Weighted MCL												***25.8***	***2.2***
SWMU 7 DPT Data [b]														
7-1 through 7-11 (UF)					ND									
007G001242 7-12 (UF)	Trichloroethene	1.6	5	ND	20					1/1	20.0-20.0	20	12.5	4
	R Factor/Weighted MCL												**12.5**	**4**

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G001339 7-13 (UF)					ND									
007G001442 7-14 (UF)					ND									
007G001542 7-15 (UF)	1,1-Dichloroethane	810	DNE	ND	10					1/1	10.0-10.0	10	0.01235	0
	1,1-Dichloroethene	0.044	7	ND	8.8					1/1	8.8-8.8	8.8	200	1.25714
	Trichloroethene	1.6	5	ND	6.1					1/1	6.1-6.1	6.1	3.8125	1.22
	cis-1,2-Dichloroethene	61	70	ND	5.4					1/1	5.4-5.4	5.4	0.08852	0.07714
	R Factor/Weighted MCL												**203.913**	**2.55428**
007G001636 7-16 (UF)	Tetrachloroethene	1.1	5	ND	11.1					1/1	11.1-11.1	11.1	10.0909	2.22
	cis-1,2-Dichloroethene	61	70	ND	17.4					1/1	17.4-17.4	17.4	0.28525	0.24857
	R Factor/Weighted MCL												**10.3762**	**2.46857**
007G001741 7-17 (UF)				ND	ND									
007G001841 7-18 (UF)				ND	ND									
007G001942 7-19 (UF)	1,1-Dichloroethane	810	DNE	ND	48.2					1/1	48.2-48.2	48.2	0.05951	0
	1,1-Dichloroethene	0.044	7	ND	43.7					1/1	43.7-43.7	43.7	993.182	6.24286
	Trichloroethene	1.6	5	ND	9					1/1	9.0-9.0	9	5.625	1.8
	R Factor/Weighted MCL												**998.867**	**8.04286**
007G002038 7-20 (UF)				ND	ND									

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G002136 7-21 (UF)	1,1-Dichloroethane	810	DNE	ND	320					1/1	320.0-320.	320	0.39506	0
	cis-1,2-Dichloroethene	61	70	ND	200					1/1	200.0-200.	200	3.27869	2.85714
	R Factor/Weighted MCL												**3.67375**	**2.85714**
007G002243 7-22 (UF)	1,1-Dichloroethane	810	DNE	ND	5.3	NS				1/1	5.3-5.3	5.3	0.00648	0
	Trichloroethene	1.6	5	ND	4.2	NS				1/1	4.2-4.2	4.2	2.64375	0.846
	R Factor/Weighted MCL												**2.65023**	**0.846**
007G002343 7-23 (UF)				ND	ND									
007G002437 7-24 (UF)						ND								
007G002544 7-25 (UF)						ND								
007G002644 7-26 (UF)						ND								
007G002745 7-27 (UF)						ND								
007G002936 7-29 (UF)	Tetrachloroethene	1.1	5	ND		8				1/1	8.0-8.0	8	7.27273	1.6
	Trichloroethene	1.6	5	ND		12.6				1/1	12.6-12.6	12.6	7.875	2.52
	R Factor/Weighted MCL												**15.1477**	**4.12**
007G003047 7-30 (UF)	Tetrachloroethene	1.1	5	ND	NS	120				1/1	120.0-120.	120	109.091	24
	Trichloroethene	1.6	5	ND	NS	7.9				1/1	7.9-7.9	7.9	4.9375	1.58
	R Factor/Weighted MCL												**114.029**	**25.58**

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G003145 7-31 (UF)						ND								
007G003245 7-32 (UF)	Trichlorofluoromethane	1,300	DNE	ND		8.5				1/1	8.5-8.5	8.5	0.00654	0
	m+p Xylene	DNE	DNE	ND		4.9				1/1	4.9-4.9	4.9	0	0
	R Factor/Weighted MCL												**0.00654**	**0**
007G003336 7-33 (UF)	1,1-Dichloroethane	810	DNE	ND		8.2				1/1	8.2-8.2	8.2	0.01012	0
	1,1-Dichloroethene	0.044	7	ND		9.4				1/1	9.4-9.4	9.4	213.636	1.34286
	R Factor/Weighted MCL												**213.646**	**1.34286**
007G003445 7-34 (UF)							ND							
007G003549 7-35 (UF)	1,1-Dichloroethane	810	DNE	ND			44.2			1/1	44.2-44.2	44.2	0.05457	0
	1,1-Dichloroethene	0.044	7	ND			79.7			1/1	79.7-79.7	79.7	1,811.36	11.3857
	Carbon tetrachloride	0.16	5	ND			10.3			1/1	10.3-10.3	10.3	64.375	2.06
	Chlorobromomethane	DNE	DNE	ND			31.9			1/1	31.9-31.9	31.9	0	0
	Trichloroethene	1.6	5	ND			117			1/1	117.0-117.	117	73.125	23.4
	cis-1,2-Dichloroethene	61	70	ND			9.9			1/1	9.9-9.9	9.9	0.16262	0.14171
	R Factor/Weighted MCL												**1,949.08**	**36.9874**
007G003658 7-36 (MF)	Dichlorodifluoromethane	390	DNE	ND			6.1			1/1	6.1-6.1	6.1	0.01559	0
	R Factor/Weighted MCL												**0.01559**	**0**
007G003760 7-37 (MF)							ND							

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G003849 7-38 (MF)							ND							
007G003934 7-39 (UF)	Trichloroethene	1.6	5	ND			6.5			1/1	6.5-6.5	6.5	4.0875	1.308
	R Factor/Weighted MCL												**4.0875**	**1.308**
007G004042 7-40 (UF)	1,1-Dichloroethane	810	DNE	ND			1.7			1/1	1.7-1.7	1.7	0.00206	0
	R Factor/Weighted MCL												**0.00206**	**0**
007G004143 7-41 (UF)	Trichloroethene	1.6	5	ND			20			1/1	20.0-20.0	20	12.5	4
	cis-1,2-Dichloroethene	61	70	ND			1.7			1/1	1.7-1.7	1.7	0.0282	0.02457
	R Factor/Weighted MCL												**12.5282**	**4.02457**
007G004240 7-42 (UF)	Carbon tetrachloride	0.16	5	ND			6.4			1/1	6.4-6.4	6.4	39.8125	1.274
	Dichlorodifluoromethane	390	DNE	ND			15			1/1	390-390	390	0.039	
	Chloroform	0.15	100	ND			2.8			1/1	2.8-2.8	2.8	18.4667	0.0277
	Methylene chloride	4.1	5	ND			6.7			1/1	6.7-6.7	6.7	1.62927	1.336
	R Factor/Weighted MCL												**59.95**	**2.6377**
007G004346 7-43 (UF)							ND							
007G004446 7-44 (UF)	Trichloroethene	1.6	5	ND			1.4			1/1	1.4-1.4	1.4	0.885	0.284
	R Factor/Weighted MCL												**0.8875**	**0.284**
007G004545 7-45 (UF)							ND							
007G004646 7-46 (UF)							ND							

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G004746 7-47 (UF)	Trichloroethene	1.6	5	ND			5.0 J			1/1	5.0-5.0	5	3.125	1
	R Factor/Weighted MCL												**3.125**	**1**
007G004845 7-48 (UF)	1,2-Dichloroethane	0.12	5	ND			11.2			1/1	11.2-11.2	11.2	93.3333	2.24
	R Factor/Weighted MCL												**93.3333**	**2.24**
007G004934 7-49 (UF)	Trichloroethene	1.6	5	ND			8.1			1/1	8.1-8.1	8.1	5.08125	1.626
	R Factor/Weighted MCL												**5.08125**	**1.626**
007G005061 7-50 (MF)							ND							
007G005154 7-51 (MF)							ND							
007G005265 7-52 (MF)							ND							
007G005364 7-53 (MF)							ND							
007G005458 7-54 (MF)							ND							
007G005560 7-55 (MF)							ND							
007G005650 7-56 (MF)							ND							
007G005757 7-57 (MF)	Chloroform	0.15	100					6		1/1	6.0-6.0	6	40	0.06
	Tetrachloroethene	1.1	5	ND				42.6		1/1	42.6-42.6	42.6	38.7273	8.52
	Trichloroethene	1.6	5	ND				128		1/1	128.0-128.	128	80	25.6
	R Factor/Weighted MCL												**158.727**	**34.18**

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G005872 7-58 (LF)	Carbon tetrachloride	0.16	5	ND				7.4		1/1	7.4-7.4	7.4	46.25	1.48
	Chloroform	0.15	100	ND				3.3 J		1/1	3.3-3.3	3.3	22	0.033
	Trichloroethene	1.6	5	ND				16		1/1	16.0-16.0	16	10	3.2
	R Factor/Weighted MCL												**78.25**	**4.713**
007G005965 7-59 (LF)	Carbon tetrachloride	0.16	5	ND				1.0 J		1/1	1.0-1.0	1	6.25	0.2
	Chloroform	0.15	100	ND				1.1 J		1/1	1.1-1.1	1.1	7.33333	0.011
	Trichloroethene	1.6	5	ND				13.8		1/1	13.8-13.8	13.8	8.625	2.76
	cis-1,2-Dichloroethene	61	70	ND				47.3		1/1	47.3-47.3	47.3	0.77541	0.67571
	R Factor/Weighted MCL												**22.9837**	**3.64671**
007G006079 7-60 (MF)								ND						
007G006157 7-61 UF)								ND						
007G006167 7-61 (MF)								ND						
007G006176 7-61 (LF)								ND						
007G006264 7-62 (LF)	Acetone	3,700	DNE						62.0 J	1/1	62.0-62.0	62	0.01676	0
	Acrylonitrile	0.12	DNE	ND					179	1/1	179.0-179.	179	1,491.67	0
	Benzene	0.36	5	ND					653.0 D	1/1	653.0-653.	653	1,813.89	130.6
	Chloromethane	1.4	DNE	ND					60.2	1/1	60.2-60.2	60.2	43	0
	Ethylbenzene	1,300	700	ND					49.6	1/1	49.6-49.6	49.6	0.03815	0.07086
	Styrene	1,600	100	ND					29.5	1/1	29.5-29.5	29.5	0.01844	0.295
	Toluene	750	1,000	ND					169	1/1	169.0-169.	169	0.22533	0.169
	Trichloroethene	1.6	5	ND					7.7	1/1	7.7-7.7	7.7	4.80625	1.538
	Xylene (Total)	12,000	10,000	ND					70.2	1/1	70.2-70.2	70.2	0.00585	0.00702
	R Factor/Weighted MCL												**3,353.67**	**132.68**

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G006345 7-63 (UF)	cis-1,2-Dichloroethene	61	70	ND					3.2 J	1/1	3.2-3.2	3.2	0.05246	0.04571
	R Factor/Weighted MCL												**0.05246**	**0.04571**
007G006358 7-63 (MF)									ND					
007G006445 7-64 (UF)	1,1-Dichloroethene	0.044	7	ND					2.5 J	1/1	2.5-2.5	2.5	56.8182	0.35714
	Benzene	0.36	5	ND					37.5	1/1	37.5-37.5	37.5	104.167	7.5
	Ethylbenzene	1,300	700	ND					4.7 J	1/1	4.7-4.7	4.7	0.00362	0.00671
	Styrene	1,600	100	ND					2.1 J	1/1	2.1-2.1	2.1	0.00131	0.021
	Tetrachloroethene	1.1	5	ND					1.8 J	1/1	1.8-1.8	1.8	1.63636	0.36
	Toluene	750	1,000	ND					18.6	1/1	18.6-18.6	18.6	0.0248	0.0186
	Xylenes (total)	12,000	10,000	ND					6.4	1/1	6.4	6.4	0	0
	Trichloroethene	1.6	5	ND					82.1	1/1	82.1-82.1	82.1	51.3125	16.42
	cis-1,2-Dichloroethene	61	70	ND					1.6 J	1/1	1.6-1.6	1.6	0.02623	0.02286
	R Factor/Weighted MCL												213.99	24.7063
007G006455 7-64 (MF)	Acetone	3,700	DNE	ND					188	1/1	188.0-188.	188	0.05081	0
	R Factor/Weighted MCL												**0.05081**	**0**
007G006467 7-64 (LF)	Chloroform	0.15	100	ND					9.8	1/1	9.8-9.8	9.8	65.2667	0.0979
	Trichloroethene	1.6	5	ND					18.8	1/1	18.8-18.8	18.8	11.75	3.76
	R Factor/Weighted MCL												**77.0167**	**3.8579**

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G006548 6-65 (MF)	Acetone	3,700	DNE	ND					50.0 J	1/1	50.0-50.0	50	0.01351	0
	R Factor/Weighted MCL												**0.01351**	**0**
007G006567 7-65 (LF)									ND					
007G006650 7-66 (MF)	1,1-Dichloroethane	810	DNE						2.6 J	1/1	2.6-2.6	2.6	0.00321	0
	1,1-Dichloroethene	0.044	7	ND					3.7 J	1/1	3.7-3.7	3.7	84.0909	0.52857
	Trichloroethene	1.6	5	ND					1.7 J	1/1	1.7-1.7	1.7	1.0625	0.34
	cis-1,2-Dichloroethene	61	70	ND					1.6 J	1/1	1.6-1.6	1.6	0.02623	0.02286
	R Factor/Weighted MCL												**85.1828**	**0.89143**
007G006663 7-66 (LF)	1,1-Dichloroethene	0.044	7	ND					0.9 J	1/1	0.9-0.9	0.9	19.5455	0.12286
	R Factor/Weighted MCL								ND				**19.5455**	**0.12286**
007G006751 7-67 (UF)									ND					
007G006756 7-67 (MF)									ND					
007G006760 7-67 (LF)									ND					
007G006765 7-67 (LF)									ND					
007G006772 7-67 (LF)	Acetone	3,700	DNE						538.0 D	1/1	538.0-538.	538	0.14541	0
	Chloroform	0.15	100	ND					2.1 J	1/1	2.1-2.1	2.1	13.8667	0.0208
	Trichloroethene	1.6	5	ND					1.7 J	1/1	1.7-1.7	1.7	1.0625	0.34
	R Factor/Weighted MCL												**15.0746**	**0.3608**

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G006848 7-68 (UF)	1,1-Dichloroethane	810	DNE	ND					1.9	1/1	1.9-1.9	1.9	0.00235	0
	1,1-Dichloroethene	0.044	7	ND					3.2	1/1	3.2-3.2	3.2	72.2727	0.45429
	Acetone	3,700	DNE	ND					200	1/1	200.0-200.	200	0.05405	0
	Trichloroethene	1.6	5	ND					2.6	1/1	2.6-2.6	2.6	1.63125	0.522
	R Factor/Weighted MCL												**73.9604**	**0.97629**
007G006853 7-68 (UF)	1,1-Dichloroethane	810	DNE	ND					2.7	1/1	2.7-2.7	2.7	0.00332	0
	1,1-Dichloroethene	0.044	7	ND					5.1	1/1	5.1-5.1	5.1	115	0.72286
	Acetone	3,700	DNE	ND					50.9 J	1/1	50.9-50.9	50.9	0.01376	0
	Trichloroethene	1.6	5	ND					3.7	1/1	3.7-3.7	3.7	2.31875	0.742
	R Factor/Weighted MCL												**117.336**	**1.46486**
007G006858 7-68 (MF)	1,1-Dichloroethane	810	DNE	ND					2.4	1/1	2.4-2.4	2.4	0.00294	0
	1,1-Dichloroethene	0.044	7	ND					4.3	1/1	4.3-4.3	4.3	98.4091	0.61857
	Acetone	3,700	DNE	ND					1380.0 D	1/1	1380.0-138	1,380	0.37297	0
	Trichloroethene	1.6	5	ND					1.6 J	1/1	1.6-1.6	1.6	1	0.32
	R Factor/Weighted MCL												**99.785**	**0.93857**
007G006864 7-68 (MF)	1,1-Dichloroethene	0.044	7	ND					2.0 J	1/1	2.0-2.0	2	45.4545	0.28571
	Acetone	3,700	DNE	ND					562.0 D	1/1	562.0-562.	562	0.15189	0
	Carbon tetrachloride	0.16	5	ND					17.4	1/1	17.4-17.4	17.4	108.75	3.48
	Chloroform	0.15	100	ND					27.7	1/1	27.7-27.7	27.7	184.667	0.277
	R Factor/Weighted MCL												**339.023**	**4.04271**

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G006869 7-68 (MF)	1,1-Dichloroethene	0.044	7	ND					2.3 J	1/1	2.3-2.3	2.3	52.2727	0.32857
	Carbon tetrachloride	0.16	5	ND					23.2	1/1	23.2-23.2	23.2	145	4.64
	Chloroform	0.15	100	ND					22.4	1/1	22.4-22.4	22.4	149.333	0.224
	Trichloroethene	1.6	5	ND					1.2 J	1/1	1.2-1.2	1.2	0.75	0.24
	R Factor/Weighted MCL												**347.356**	**5.43257**
007G006873 7-68 (LF)	Carbon tetrachloride	0.16	5	ND					15.2	1/1	15.2-15.2	15.2	95	3.04
	Chloroform	0.15	100	ND					23.3	1/1	23.3-23.3	23.3	155.333	0.233
	Trichloroethene	1.6	5	ND					8.2	1/1	8.2-8.2	8.2	5.14375	1.646
	cis-1,2-Dichloroethene	61	70	ND					5.6	1/1	5.6-5.6	5.6	0.09246	0.08057
	R Factor/Weighted MCL												**255.569**	**4.99957**
007G006878 7-68 (LF)	Carbon tetrachloride	0.16	5	ND					6.5	1/1	6.5-6.5	6.5	40.375	1.292
	Chloroform	0.15	100	ND					8.1	1/1	8.1-8.1	8.1	53.8667	0.0808
	Trichloroethene	1.6	5	ND					6.4	1/1	6.4-6.4	6.4	4.0125	1.284
	cis-1,2-Dichloroethene	61	70	ND					5.1	1/1	5.1-5.1	5.1	0.08393	0.07314
	R Factor/Weighted MCL												**98.3381**	**2.72994**
007G006883 7-68 (LF)	Acetone	3,700	DNE	ND					594.0 D	1/1	594.0-594	594	0.16054	0
	Carbon tetrachloride	0.16	5	ND					1.3 J	1/1	1.3-1.3	1.3	8.125	0.26
	Chloroform	0.15	100	ND					4.1 J	1/1	4.1-4.1	4.1	27.3333	0.041
	Trichloroethene	1.6	5	ND					1.3 J	1/1	1.3-1.3	1.3	0.8125	0.26
	R Factor/Weighted MCL												36.4313	0.561
007G006888 7-68 (LF)	Carbon tetrachloride	0.16	5	ND					1.4 J	1/1	1.4-1.4	1.4	8.75	0.28
	Chloroform	0.15	100	ND					3.9 J	1/1	3.9-3.9	3.9	26	0.039
	R Factor/Weighted MCL												**34.75**	**0.319**

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G006960 7-69 (MF)	1,1-Dichloroethane	810	DNE	ND					36.5	1/1	36.5-36.5	36.5	0.04506	0
	1,1-Dichloroethene	0.044	7	ND					183	1/1	183.0-183.	183	4,159.09	26.1429
	Benzene	0.36	5	ND					5.1	1/1	5.1-5.1	5.1	14.0833	1.014
	Carbon tetrachloride	0.16	5	ND					199	1/1	199.0-199.	199	1,243.75	39.8
	Chloroform	0.15	100	ND					180	1/1	180.0-180.	180	1,200	1.8
	Trichloroethene	1.6	5	ND					1160.0 DJ	1/1	1160.0-116	1,160	725	232
	cis-1,2-Dichloroethene	61	70	ND					29.2	1/1	29.2-29.2	29.2	0.47869	0.41714
	R Factor/Weighted MCL												**7,342.45**	**301.174**
007G006990 7-69 (LF)	Trichloroethene	1.6	5	ND					1.6 J	1/1	1.6-1.6	1.6	1	0.32
	R Factor/Weighted MCL												**1**	**0.32**
007G007046 7-70 (UF)	1,1-Dichloroethane	810	DNE	ND					3.2 J	1/1	3.2-3.2	3.2	0.00395	0
	1,1-Dichloroethene	0.044	7	ND					10.7	1/1	10.7-10.7	10.7	243.182	1.52857
	Chloroform	0.15	100	ND					1.9 J	1/1	1.9-1.9	1.9	12.6667	0.019
	Trichloroethene	1.6	5	ND					16.9 J	1/1	16.9-16.9	16.9	10.5625	3.38
	R Factor/Weighted MCL												**266.415**	**4.92757**
007G007068 7-70 (MF)	1,1-Dichloroethene	0.044	7	ND					4.3 J	1/1	4.3-4.3	4.3	97.7273	0.61429
	Chloroform	0.15	100	ND					47.4	1/1	47.4-47.4	47.4	316	0.474
	Trichloroethene	1.6	5	ND					190.0 J	1/1	190.0-190.	190	118.75	38
	R Factor/Weighted MCL												**532.477**	**39.0883**
007G007088 7-70 (LF)	1,1-Dichloroethene	0.044	7	ND					1.0 J	1/1	1.0-1.0	1	22.7273	0.14286
	Carbon tetrachloride	0.16	5	ND					3.5 J	1/1	3.5-3.5	3	21.875	0.7
	Chloroform	0.15	100	ND					11.3	1/1	11.3-11.3	11.3	75.3333	0.113
	Trichloroethene	1.6	5	ND					38.9	1/1	38.9-38.9	38.9	24.3125	7.78
	R Factor/Weighted MCL												**144.248**	**8.73586**

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G007146 7-71 (UF)	1,1-Dichloroethane	810	DNE	ND					1.7 J	1/1	1.7-1.7	1.7	0.0021	0
	Acetone	3,700	DNE	ND					1020.0 DJ	1/1	1020.0-102	1,020	0.27568	0
	R Factor/Weighted MCL												**0.27778**	**0**
007G007168 7-71 (MF)	1,1-Dichloroethene	0.044	7	ND					2.7	1/1	2.7-2.7	2.7	61.1364	0.38429
	Carbon tetrachloride	0.16	5	ND					121	1/1	121.0-121.	121	756.25	24.2
	Chloroform	0.15	100	ND					60.8	1/1	60.8-60.8	60.8	405.333	0.608
	Trichloroethene	1.6	5	ND					422.0 D	1/1	422.0-422.	422	263.75	84.4
	R Factor/Weighted MCL												**1,486.47**	**109.592**
007G007188 7-71 (LF)	1,1-Dichloroethene	0.044	7	ND					2.6	1/1	2.6-2.6	2.6	60	0.37714
	Carbon tetrachloride	0.16	5	ND					34.3	1/1	34.3-34.3	34.3	214.375	6.86
	Chloroform	0.15	100	ND					15.9	1/1	15.9-15.9	15.9	106	0.159
	Trichloroethene	1.6	5	ND					14	1/1	14.0-14.0	14	8.75	2.8
	R Factor/Weighted MCL												**389.125**	**10.1961**
007G007246 7-72 (UF)	1,1-Dichloroethane	810	DNE	ND					4.1	1/1	4.1-4.1	4.1	0.005	0
	1,1-Dichloroethene	0.044	7	ND					8.7	1/1	8.7-8.7	8.7	196.818	1.23714
	Trichloroethene	1.6	5	ND					16.1	1/1	16.1-16.1	16.1	10.0625	3.22
	R Factor/Weighted MCL												**206.886**	**4.45714**
007G007268 7-72 (MF)	1,1-Dichloroethene	0.044	7	ND					1.6 J	1/1	1.6-1.6	1.6	36.3636	0.22857
	Carbon tetrachloride	0.16	5	ND					10.3	1/1	10.3-10.3	10.3	64.375	2.06
	Chloroform	0.15	100	ND					30.6	1/1	30.6-30.6	30.6	204	0.306
	Trichloroethene	1.6	5	ND					122	1/1	122.0-122.	122	76.25	24.4
	R Factor/Weighted MCL												**380.989**	**26.9946**

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G007290 7-72 (LF)	1,1-Dichloroethene	0.044	7	ND					2.1 J	1/1	2.1-2.1	2.1	47.7273	0.3
	Acetone	3,700	DNE	ND					197	1/1	197.0-197.	197	0.05324	0
	Carbon tetrachloride	0.16	5	ND					28.5	1/1	28.5-28.5	28.5	178.125	5.7
	Chloroform	0.15	100	ND					21.1	1/1	21.1-21.1	21.1	140.667	0.211
	Trichloroethene	1.6	5	ND					8.7	1/1	8.7-8.7	8.7	5.44375	1.742
	R Factor/Weighted MCL												**372.016**	**7.953**
007G007368 7-73 (MF)	Acetone	3,700	DNE	ND					164	1/1	164.0-164.	164	0.04432	0
	Chloroform	0.15	100	ND					2.1 J	1/1	2.1-2.1	2.1	14	0.021
	Trichloroethene	1.6	5	ND					15.3	1/1	15.3-15.3	15.3	9.5625	3.06
	R Factor/Weighted MCL												**23.6068**	**3.081**
007G007390 7-73 (LF)	Acetone	3,700	DNE	ND					44.0 J	1/1	44.0-44.0	44	0.01189	0
	R Factor/Weighted MCL												**0.01189**	**0**
007G007468 7-74 (MF)	1,1-Dichloroethene	0.044	7	ND					1.4 J	1/1	1.4-1.4	1.4	31.8182	0.2
	Chloroform	0.15	100	ND					4.3 J	1/1	4.3-4.3	4.3	28.6667	0.043
	Trichloroethene	1.6	5	ND					47.4	1/1	47.4-47.4	47.4	29.625	9.48
	R Factor/Weighted MCL												**90.1099**	**9.723**
007G007491 7-74 (LF)	Acetone	3,700	DNE	ND					33.0 J	1/1	33.0-33.0	33	0.00892	0
	Trichloroethene	1.6	5	ND					1.2 J	1/1	1.2-1.2	1.2	0.75	0.24
	R Factor/Weighted MCL												**0.75892**	**0.24**
007G007559 7-75 (UF)	Benzene	0.36	5	ND					1.4 J	1/1	1.4-1.4	1.4	3.88889	0.28
	Toluene	750	1,000	ND					1.4 J	1/1	1.4-1.4	1.4	0.00187	0.0014
	R Factor/Weighted MCL												**3.89076**	**0.2814**

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G007660 7-76 (UF)				ND					ND					
007G007680 7-76 (LF)	Trichloroethene	1.6	5	ND					9.8	1/1	9.8-9.8	9.8	6.15	1.968
	R Factor/Weighted MCL												**6.15**	**1.968**
007G007768 7-77 (LF)	Chloroform	0.15	100	ND					4.3 J	1/1	4.3-4.3	4.3	28.6667	0.043
	Tetrachloroethene	1.1	5	ND					9.7	1/1	9.7-9.7	9.7	8.78182	1.932
	Trichloroethene	1.6	5	ND					22	1/1	22.0-22.0	22	13.75	4.4
	R Factor/Weighted MCL												**51.1985**	**6.375**
007G007868 7-78 (LF)	Chloroform	0.15	100	ND					11.5	1/1	11.5-11.5	11.5	76.6667	0.115
	Trichloroethene	1.6	5	ND					2.3 J	1/1	2.3-2.3	2.3	1.4375	0.46
	R Factor/Weighted MCL												**78.1042**	**0.575**
007G007967 7-79 (MF)	1,1-Dichloroethane	810	DNE	ND					3.5 J	1/1	3.5-3.5	3.5	0.00432	0
	1,1-Dichloroethene	0.044	7	ND					10.2	1/1	10.2-10.2	10.2	231.818	1.45714
	Chloroform	0.15	100	ND					7.2	1/1	7.2-7.2	7.2	48.1333	0.0722
	Trichloroethene	1.6	5	ND					61.2	1/1	61.2-61.2	61.2	38.25	12.24
	R Factor/Weighted MCL												**318.206**	**13.7693**
007G008066 7-80 (MF)	1,1-Dichloroethene	0.044	7	ND					14.2	1/1	14.2-14.2	14.2	322.727	2.02857
	Chloroform	0.15	100	ND					3.3 J	1/1	3.3-3.3	3.3	22	0.033
	Trichloroethene	1.6	5	ND					26.2	1/1	26.2-26.2	26.2	16.375	5.24
	R Factor/Weighted MCL												**361.102**	**7.30157**

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G008087 7-80 (LF)									ND					
SWMU 15Well Data[c]														
015G01LF	1,1-Dichloroethane	810	DNE	ND	NS	NS	1.0 J	10.0 U	5.0 U	1/3	1	2.8	0.0	0.0
	1,1-Dichloroethene	0.044	7	ND	NS	NS	1.0 J	10.0 U	5.0 U	1/3	1	2.8	22.7	0.1
	Barium	2,600	2,000	232	NS	NS	155.0 J	NS	NS	1/1	155	155	0.1	0.1
	Cadmium	18	5	3.9	NS	NS	7.2	NS	NS	1/1	7.2	7.2	0.4	1.4
	Carbon tetrachloride	0.16	5	ND	NS	NS	2.0 J	2.0 J	2.4 J	3/3	2.00 - 2.40	2.1	15.0	0.5
	Methylene chloride	4.1	5	ND	NS	NS	10.0 U	10.0 U	3.8 J	1/3	3.8	4.6	0.9	0.8
	Selenium	180	50	ND	NS	NS	1.2 J	NS	NS	1/1	1.2	1.2	0.0	0.0
	Tetrachloroethene	1.1	5	ND	NS	NS	10.0 U	10.0 U	1.4 J	1/3	1.4	3.8	1.3	0.3
	Trichloroethene	1.6	5	ND	NS	NS	10	6.0 J	7.1	3/3	6.00 - 10.00	7.7	6.3	2.0
	R Factor/Weighted MCL												*46.6*	*5.2*
015G01UF	Barium	2,600	2,000	232	NS	NS	229	NS	NS	1/1	229	229	0.1	0.1
	Benzene	0.36	5	ND	NS	NS	4600.0 D	3,700	2800.0 E	3/3	2800.00 - 4600.00	3,700	12,777.8	920.0
	Cobalt	2,200	DNE	16.2	NS	NS	9.9 J	NS	NS	1/1	9.9	9.9	0.0	0.0
	Ethylbenzene	1,300	700	ND	NS	NS	66	28.0 J	130	3/3	28.00 - 130.00	74.7	0.1	0.2
	Lead	DNE	15[a]	6.6	NS	NS	6.2	NS	NS	1/1	6.2	6.2	0.9	0.4
	Phenol	22,000	DNE	ND	NS	NS	16	NS	NS	1/1	16	16	0.0	0.0
	Selenium	180	50	ND	NS	NS	9.8	NS	NS	1/1	9.8	9.8	0.1	0.2
	Silver	180	DNE	ND	NS	NS	5.0 J	NS	NS	1/1	5	5	0.0	0.0
	TPH - Diesel Range Organics	100	DNE	ND	NS	NS	110	NS	NS	1/1	110	110	1.1	0.0
	Toluene	750	1,000	ND	NS	NS	10.0 U	200.0 U	1.6 J	1/3	1.6	35.5	0.0	0.0
	Vanadium	260	DNE	17.4	NS	NS	13.3 J	NS	NS	1/1	13.3	13.3	0.1	0.0
	R Factor/Weighted MCL												*12,780.2*	*920.9*

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
015G02LF	1,1-Dichloroethane	810	DNE	ND	NS	NS	2.0 J	10.0 U	5.0 U	1/3	2	3.2	0.0	0.0
	1,1-Dichloroethene	0.044	7	ND	NS	NS	10.0 U	10.0 U	1.0 J	1/3	1	3.7	22.7	0.1
	Barium	2,600	2,000	232	NS	NS	136.0 J	NS	NS	1/1	136	136	0.1	0.1
	Benzene	0.36	5	ND	NS	NS	10.0 U	10.0 U	3.2 J	1/3	3.2	4.4	8.9	0.6
	Carbon disulfide	1,000	DNE	ND	NS	NS	10.0 U	7.0 J	5.0 U	1/3	7	4.8	0.0	0.0
	Chromium	180	100	39.8	NS	NS	5.6 J	NS	NS	1/1	5.6	5.6	0.0	0.1
	Trichloroethene	1.6	5	ND	NS	NS	1.0 J	10.0 U	5.0 U	1/3	1	2.8	0.6	0.2
	R Factor/Weighted MCL												*32.3*	*1.1*
015G02UF	1,1-Dichloroethane	810	DNE	ND	NS	NS	50.0 U	4.0 J	8.4	2/3	4.00 - 8.40	12.5	0.0	0.0
	1,2-Dichloroethene (total)	55	70	ND	NS	NS	50.0 U	1.0 J	3.1 J	2/3	1.00 - 3.10	9.7	0.1	0.0
	2-Hexanone	DNE	DNE	ND	NS	NS	50.0 U	80	25.0 U	1/3	80	39.2	0.0	0.0
	Acetone	3,700	DNE	ND	NS	NS	240	10.0 U	50.0 U	1/3	240	90	0.1	0.0
	Arsenic	3.5	50	3.5	NS	NS	3.5 J	NS	NS	1/1	3.5	3.5	1.0	0.1
	Barium	2,600	2,000	232	NS	NS	312	NS	NS	1/1	312	312	0.1	0.2
	Benzene	0.36	5	ND	NS	NS	16.0 J	16	34	3/3	16.00 - 34.00	22	94.4	6.8
	Cobalt	2,200	DNE	16.2	NS	NS	8.8 J	NS	NS	1/1	8.8	8.8	0.0	0.0
	Ethylbenzene	1,300	700	ND	NS	NS	62.0 J	5.0 J	92	3/3	5.00 - 92.00	53	0.1	0.1
	Naphthalene	1,500	DNE	ND	NS	NS	2.0 J	NS	NS	1/1	2	2	0.0	0.0
	TPH - Diesel Range Organics	100	DNE	ND	NS	NS	190	NS	NS	1/1	190	190	1.9	0.0
	Toluene	750	1,000	ND	NS	NS	50.0 U	1.0 J	3.0 J	2/3	1.00 - 3.00	9.7	0.0	0.0
	Xylene (Total)	12,000	10,000	ND	NS	NS	50.0 U	8.0 J	12	2/3	8.00 - 12.00	15	0.0	0.0
	BEHP	4.8	DNE	ND	NS	NS	1.0 J	NS	NS	1/1	1	1	0.2	0.0
	R Factor/Weighted MCL												*97.9*	*7.2*

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
015G03LF	Barium	2,600	2,000	232	NS	NS	267	NS	NS	1/1	267	267	0.1	0.1
	R Factor/Weighted MCL												*0.1*	*0.1*
015G03UF	Acetone	3,700	DNE	ND	NS	NS	68	10.0 U	50.0 U	1/3	68	32.7	0.0	0.0
	Barium	2,600	2,000	232	NS	NS	309	NS	NS	1/1	309	309	0.1	0.2
	Chromium	180	100	39.8	NS	NS	65.2	NS	NS	1/1	65.2	65.2	0.4	0.7
	Cobalt	2,200	DNE	16.2	NS	NS	15.2 J	NS	NS	1/1	15.2	15.2	0.0	0.0
	Lead	DNE	15 [a]	6.6	NS	NS	6.6	NS	NS	1/1	6.6	6.6	1.0	0.4
	Nickel	730	100	33.4	NS	NS	39.2 J	NS	NS	1/1	39.2	39.2	0.1	0.4
	Selenium	180	50	ND	NS	NS	1.4 J	NS	NS	1/1	1.4	1.4	0.0	0.0
	Vanadium	260	DNE	17.4	NS	NS	34.2 J	NS	NS	1/1	34.2	34.2	0.1	0.0
	BEHP	4.8	DNE	ND	NS	NS	1.0 J	NS	NS	1/1	1	1	0.2	0.0
	R Factor/Weighted MCL												1.9	1.7
015G04LF	2-Hexanone	DNE	DNE	ND	NS	NS	10.0 U	10.0 U	12.0 BJ	1/3	12	7.3	0.0	0.0
	Acetone	3,700	DNE	ND	NS	NS	10.0 UJ	7.0 J	50.0 U	1/3	7	12.3	0.0	0.0
	Barium	2,600	2,000	232	NS	NS	186.0 J	NS	NS	1/1	186	186	0.1	0.1
	Chromium	180	100	39.8	NS	NS	10.1	NS	NS	1/1	10.1	10.1	0.1	0.1
	Trichloroethene	1.6	5	ND	NS	NS	2.0 J	1.0 J	2.0 J	3/3	1.00 - 2.00	1.7	1.3	0.4
	R Factor/Weighted MCL												*1.4*	*0.6*
015G04UF	Acetone	3,700	DNE	ND	NS	NS	120	10.0 U	50.0 U	1/3	120	50	0.0	0.0
	Arsenic	3.5	50	3.5	NS	NS	2.0 J	NS	NS	1/1	2	2	0.6	0.0
	Barium	2,600	2,000	232	NS	NS	59.9 J	NS	NS	1/1	59.9	59.9	0.0	0.0
	R Factor/Weighted MCL												*0.6*	*0.1*

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
SWMU 15 DPT Data[c]														
15G0149 15-1 (MF)	Ethylbenzene	1,300	700	NS	8.1					NA	NA	NA	0.006231	0.0115714286
	Xylene(total)	12,000	10,000	NS	60.1					NA	NA	NA	0.005008	0.00601
	Styrene	1,600	100	NS	14.4					NA	NA	NA	0.009	0.144
	Isopropylbenzene/Bromo benzene			NS	5.2					NA	NA	NA	NA	NA
	R Factor/Weighted MCL												**0.0202391**	**0.16158142857**
15G02 15-2 (MF)					ND					NA	NA	NA	NA	NA
15G0348 15-3 (MF)					ND					NA	NA	NA	NA	NA
	R Factor/Weighted MCL												**0**	**0**
15G0445 15-4 (MF)	Styrene	1,600	100	ND	5.5					NA	NA	NA	0.003438	0.055
	Xylene(total)	12,000	10,000	ND	9.4					NA	NA	NA	0.0008	0.00094
	R Factor/Weighted MCL												**0.004221**	**0.05594**
15G0540 15-5 (UF)	Benzene	0.36	5	ND	741					NA	NA	NA	2,058.3333	148.2
	Ethylbenzene	1,300	700	ND	27.2					NA	NA	NA	0.0209231	0.0388571429
	R Factor/Weighted MCL												**2,058.3543**	**148.238857143**
15G0650 15-6 (MF)	ND			ND						NA	NA	NA	0	0
	R Factor/Weighted MCL												0	0
15G0747 15-7 (MF)	ND			ND						NA	NA	NA	0	0
	R Factor/Weighted MCL												0	0
15G0843 15-8 (MF)	Benzene	0.36	5	ND	176					NA	NA	NA	488.888889	35.2
	Ethylbenzene	1,300	700	ND	17.7					NA	NA	NA	0.0136154	0.0252857143
	R Factor/Weighted MCL												**488.902504**	**35.2252857143**

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
15G0942 15-9 (MF)	ND			ND						NA	NA	NA		
	R Factor/Weighted MCL												**0**	**0**
15G1045 15-10 (MF)	Benzene	0.36	5	ND	9.8					NA	NA	NA	27.2222222	1.96
	Toluene	750	1,000	ND	12.9					NA	NA	NA	0.0172	0.0129
	Xylene(total)	12,000	10,000	ND	10.4					NA	NA	NA	0.0009	0.00104
	Isopropylbenzene/Bromo benzene			ND	5.1					NA	NA	NA	0	0
	R Factor/Weighted MCL												**27.2402889**	**1.97394**
15G1142 15-11 (MF)	Benzene	0.36	5	ND	780								2,166.6667	156
	Ethylbenzene	1,300	700	ND	490					NA	NA	NA	0.37692308	0.7
	Xylene(total)	12,000	10,000	ND	27.3					NA	NA	NA	0.002275	0.00273
	n-propylbenzene			ND	22.1					NA	NA	NA	0	0
	R Factor/Weighted MCL												**2,167.0459**	**156.70273**
15G1243 15-12 (MF)	Benzene	0.36	5	ND	399					NA	NA	NA	1,108.3333	79.8
	Ethylbenzene	1,300	700	ND	140					NA	NA	NA	0.10769231	0.2
	Xylene(total)	12,000	10,000	ND	21.5					NA	NA	NA	0.001792	0.00215
	Isopropylbenzene/Bromo benzene			ND	20.6					NA	NA	NA	0	0
	n-propylbenzene			ND	10					NA	NA	NA	0	0
	1,2,4-Trimethylbenzene	300		ND	11.9					NA	NA	NA	0.0396667	0
	R Factor/Weighted MCL												**1,108.47**	**23,670**
15G1338 15-13 (UF)				ND						NA	NA	NA	0	0
	R Factor/Weighted MCL												**0**	**0**

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
15G1442 15-14 (UF)	Benzene	0.36	5	ND	100					NA	NA	NA	277.777778	20
	Ethylbenzene	1,300	700	ND	330					NA	NA	NA	0.25384615	0.47142857143
	Xylene(total)	12,000	10,000	ND	45					NA	NA	NA	0.00375	0.0045
	n-propylbenzene			ND	20.2					NA	NA	NA	0	
	R Factor/Weighted MCL												**278.035374**	**20.4759285714**
15G1543 15-15 (MF)	Benzene	0.36	5	ND	60					NA	NA	NA	166.666667	12
	Ethylbenzene	1,300	700	ND	260					NA	NA	NA	0.2	0.37142857143
	Xylene(total)	12,000	10,000	ND	19.5					NA	NA	NA	0.001625	0.00195
	n-propylbenzene			ND	18.2					NA	NA	NA	0	0
	Bromomethane	8,781	DNE	ND	6,323					NA	NA	NA	7.24137931	12.3733785714
	1,1-Dichloroethane		DNE	ND						NA	NA	NA	0.028	
	R Factor/Weighted MCL												174.12967	
15G1649 15-16 (MF)	Benzene	0.36	5	ND	48.8					NA	NA	NA	135.555556	9.76
	Toluene	750	1,000	ND	5					NA	NA	NA	0.006667	0.005
	Ethylbenzene	1,300	700	ND	124					NA	NA	NA	0.0953846	0.17714285714
	Xylene(total)	12,000	10,000	ND	12.5					NA	NA	NA	0.001042	0.00125
	Isopropylbenzene/Bromo benzene			ND	6.9					NA	NA	NA		
	n-propylbenzene			ND	20.3					NA	NA	NA		
	sec-Butlybenzene	61		ND	6.6					NA	NA	NA	0.10819672	
	R Factor/Weighted MCL												**135.766845**	**9.94339285714**
15G1736 15-17 (UF)				ND						NA	NA	NA	0	0
	R Factor/Weighted MCL												**0**	**0**

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
15G1845 15-18 (MF)	Benzene	0.36	5	ND	13.9					NA	NA	NA	38.6111111	2.78
	Ethylbenzene	1,300	700	ND	81.7					NA	NA	NA	0.0628462	0.11671428571
	Xylene(total)	12,000	10,000	ND	14.6					NA	NA	NA	0.001217	0.00146
	n-propylbenzene			ND	11					NA	NA	NA	0	0
	sec-Butlybenzene	61		ND	5					NA	NA	NA	0.0819672	0
	R Factor/Weighted MCL												**38.7571411**	**2.89817428571**
15G1946 15-19 (MF)	Ethylbenzene	1,300	700	ND	62.6					NA	NA	NA	0.0481538	0.0894285714
	Xylene(total)	12,000	10,000	ND	8.5					NA	NA	NA	0.0007	0.00085
	n-propylbenzene			ND	14.9					NA	NA	NA	0	0
	1,2,4-Trimethylbenzene	300		ND	7.3					NA	NA	NA	0.0243333	0
	R Factor/Weighted MCL									NA	NA	NA	**0.0731955**	**0.0902785714**
15G2045 15-20 (MF)	Benzene	0.36	5	ND	9.7					NA	NA	NA	26.9444444	1.94
	Toluene	750	1,000	ND	20.4					NA	NA	NA	0.0272	0.0204
	Ethylbenzene	1,300	700	ND	155					NA	NA	NA	0.11923077	0.22142857143
	Xylene(total)	12,000	10,000	ND	41.9					NA	NA	NA	0.003492	0.00419
	Isopropylbenzene/Bromo benzene			ND	6.2					NA	NA	NA	0	0
	n-propylbenzene			ND	28.5					NA	NA	NA	0	0
	sec-Butlybenzene	61		ND	5.2					NA	NA	NA		
	R Factor/Weighted MCL												**27.0943669**	**2.18601857143**
SWMU 21 Well Data														
021G01LF	Barium	2,600	2,000	232	NS	NS	290	NS	NS	1/1	290	290	0.1	0.1
	Cobalt	2,200	DNE	16.2	NS	NS	13.2 J	NS	NS	1/1	13.2	13.2	0.0	0.0

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
	BEHP	4.8	DNE	ND	NS	NS	1.0 J	NS	NS	1/1	1	1	0.2	0.0
	R Factor/Weighted MCL												*0.3*	*0.1*

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
021G02LF	Barium	2,600	2,000	232	NS	NS	251	NS	NS	1/1	251	251	0.1	0.1
	Cobalt	2,200	DNE	16.2	NS	NS	16.4 J	NS	NS	1/1	16.4	16.4	0.0	0.0
	Lead	DNE	0.125	6.6	NS	NS	3.6	NS	NS	1/1	3.6	3.6	0.6	0.2
	Silver	180	DNE	ND	NS	NS	4.3 J	NS	NS	1/1	4.3	4.3	0.0	0.0
	Vanadium	260	DNE	17.4	NS	NS	4.1 J	NS	NS	1/1	4.1	4.1	0.0	0.0
	R Factor/Weighted MCL												***0.7***	***0.4***
021G03LF	Barium	2,600	2,000	232	NS	NS	266	NS	NS	1/1	266	266	0.1	0.1
	Cobalt	2,200	DNE	16.2	NS	NS	10.8 J	NS	NS	1/1	10.8	10.8	0.0	0.0
	Silver	180	DNE	ND	NS	NS	3.5 J	NS	NS	1/1	3.5	3.5	0.0	0.0
	R Factor/Weighted MCL												***0.1***	***0.1***
021G04UF	2-Hexanone	DNE	DNE	ND	NS	NS	10.0 U	10.0 U	13.0 JB	1/3	13	7.7	0.0	0.0
	Acetone	3,700	DNE	ND	NS	NS	10.0 U	15	50.0 U	1/3	15	15	0.0	0.0
	Barium	2,600	2,000	232	NS	NS	168.0 J	NS	NS	1/1	168	168	0.1	0.1
	Carbon tetrachloride	0.16	5	ND	NS	NS	2.0 J	3.0 J	7.2	3/3	2.00 - 7.20	4.1	45.0	1.4
	Cobalt	2,200	DNE	16.2	NS	NS	23.0 J	NS	NS	1/1	23	23	0.0	0.0
	R Factor/Weighted MCL												***45.1***	***1.5***
SWMU 21 DPT Data[c]														
21G0235 21-2 (UF)	Carbon tetrachloride	0.16	5	NS	163					NA	NA	NA	**1018.75**	**32.6**
	R Factor/Weighted MCL												**1,018.75**	**32.6**
21G0348 21-3 (MF)	***R Factor/Weighted MCL***				ND								**0**	**0**
21G0440 21-4 (UF)	Carbon tetrachloride	0.16	5	NS	81.3					NA	NA	NA	**508.125**	**16.26**
	R Factor/Weighted MCL												**508.125**	**16.26**

Table A-1
Area A (SWMUs 7, 15, and 21)
Fluvial Deposits Groundwater Analytical Results (μg/L) — Hits Only

Well ID	Analyte	RBC	MCL	RC	Initial Event	Confirm. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
21G0540 21-5 (UF)	Dichlorofluoromethane	390		NS	5.4					NA	NA	NA	**0.0138462**	**??**
	Carbon tetrachloride	0.16	5	NS	5					NA	NA	NA	**31.25**	**1**
	R Factor/Weighted MCL												**31.26**	**1**
21G0641 21-6 (UF)	Dichlorofluoromethane	390		NS	6.5					NA	NA	NA	**0.0166667**	**0**
	Carbon tetrachloride	0.16	5	NS	15.2					NA	NA	NA	**95**	**3.04**
	R Factor/Weighted MCL												**95**	**3.04**

Notes:

RBC — Risk-based concentration from *Risk-Based Concentration Table* (U.S. EPA, December 22, 1997).
MCL — Maximum Contaminant Level from U.S. EPA *Drinking Water Regulations and Health Advisories* (U.S. EPA, October 1996).
RC — Reference concentration (background). The RC is two times the mean concentration of a constituent detected in samples collected from background monitoring wells that are screened in the fluvial deposits.
Rfact — R factor is the cumulative RBC exceedance based on maximum detection of compounds.
Mfact — M factor is the cumulative MCL exceedance based on maximum detection of compounds.
ND — Non-detect
NS — Not sampled
NA — Not applicable
DNE — Does not exist.
J — Estimated value because one or more quality control criteria were not met.
B — The analyte was found in the associated lab blank as well as the sample.
D — Analyte analyzed at a secondary dilution factor.
U — Analyte not detected. Value indicates method reporting limit.
a — Treatment Technology Action Level (TTAL)
b — SWMU 7 DPT data presented in the columns labeled "Initial Event, Confirmatory Event, Event 1, Event 2 and Event 3" correspond with DPT sampling events conducted in 11/94, 5/95, 11/95, 2/96, and 2/97, respectively.
c — SWMUs 15 and 21 DPT data presented in the "Initial Event" column represents data collected in May 1995.
One half of the detection limit has been used for "non-detects" to calculate the mean, which may result in the mean values exceeding the range of listed concentrations.

Table A-2
Area B (SWMU 3 and 40)
Fluvial Deposits Groundwater Monitoring Results (μg/L)

Well ID	Analyte	RBC	MCL	RC	Initial Eve.	Conf. Eve.	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
SWMU 3														
Well Data														
	Acetone	3,700	DNE	ND	1000.0 D	NS	290	10.0 U	NS	2/3	290.0-1000	431.7	0.27027	0
	Arsenic	3.5	50	3.5	5.6 J	NS	NS	NS	NS	1/1	5.6-5.6	5.6	1.6	0.112
	Barium	2,600	2,000	232	91.1 J	NS	NS	NS	NS	1/1	91.1-91.1	91.1	0.03504	0.04555
	Carbon disulfide	1,000	DNE	ND	1.0 J	NS	50.0 U	10.0 U	NS	1/3	1.0-1.0	10.3	0.001	0
	Chromium	180	100	39.8	7.2 J	NS	NS	NS	NS	1/1	7.2-7.2	7.2	0.04	0.072
003G03MF	Ethylbenzene	1,300	700	ND	2.0 J	NS	50.0 U	10.0 U	NS	1/3	2.0-2.0	10.7	0.00154	0.00286
	Lead	DNE	15 [a]	6.6	3.3	NS	NS	NS	NS	1/1	3.3-3.3	3.3	0.5	0.22
	Silver	180	DNE	ND	3.2 J	NS	NS	NS	NS	1/1	3.2-3.2	3.2	0.01778	0
	Xylene (Total)	12,000	10,000	NA	22.0 J	NS	50.0 U	4.0 J	NS	2/3	4.0-22.0	17	0.00183	0.0022
	Zinc	11,000	DNE	39.8	10.0 J	NS	NS	NS	NS	1/1	10.0-10.0	10	0.001	0
	R Factor/Weighted MCL												**2.46837**	**0.45461**
	Acetone	3,700	DNE	ND	10.0 U	NS	160	10.0 U	NS	1/4	160.0-160.	48.8	0.04324	0
	Barium	2,600	2,000	232	112.0 J	NS	NS	NS	NS	1/1	112.0-112.	112	0.04308	0.056
	Chloroform	0.15	100	ND	10.0 U	NS	2.0 J	10.0 U	NS	1/4	2.0-2.0	3.6	13.3333	0.02
003G04LF	Chromium	180	100	39.8	5.1 J	NS	NS	NS	NS	1/1	5.1-5.1	5.1	0.02833	0.051
	Cobalt	2,200	DNE	16.2	5.2 J	NS	NS	NS	NS	1/1	5.2-5.2	5.2	0.00236	0
	Lead	DNE	15 [a]	6.6	2.0 J	NS	NS	NS	NS	1/1	2.0-2.0	2	0.30303	0.13333
	R Factor/Weighted MCL												**13.7533**	**0.26033**

Table A-2
Area B (SWMU 3 and 40)
Fluvial Deposits Groundwater Monitoring Results (μg/L)

Well ID	Analyte	RBC	MCL	RC	Initial Eve.	Conf. Eve.	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
	Acetone	3,700	DNE	ND	24.0 U	NS	1,800	10.0 U	NS	1/3	1800.0-180	605.7	0.48649	0
003G05MF	Barium	2,600	2,000	232	153.0 J	NS	NS	NS	NS	1/1	153.0-153.	153	0.05885	**003G05MF**
	Chloroform	0.15	100	ND	1.0 J	NS	100.0 U	10.0 U	NS	1/3	1.0-1.0	18.7	6.66667	0.01
	Lead	DNE	15 [a]	6.6	3.5	NS	NS	NS	NS	1/1	3.5-3.5	3.5	0.5303	0.23333
	Methylene chloride	4.1	5	ND	10.0 U	NS	36.0 J	10.0 U	NS	1/3	36.0-36.0	15.3	8.78049	7.2
003G05MF	bis(2-Ethylhexyl)phthalate (BEHP)	4.8	DNE	ND	1.0 J	NS	NS	NS	NS	1/1	1.0-1.0	1	0.20833	0
	R Factor/Weighted MCL												**16.7311**	**7.51983**
	2-Butanone (MEK)	1,900	DNE	ND	10.0 U	NS	140	10.0 U	NS	1/3	140.0-140.	50	0.07368	0
	Acetone	3,700	DNE	ND	38.0 J	NS	1800.0 U	80	NS	2/3	38.0-80.0	339.3	0.02162	0
	Barium	2,600	2,000	232	193.0 J	NS	NS	89.3 J	NS	2/2	89.3-193.0	141.2	0.07423	0.0965
	Chloromethane	1.4	DNE	NA	10.0 U	NS	37.0 J	10.0 U	NS	1/3	37.0-37.0	15.7	26.4286	0
0GMG06MF (GM-6)	Stirophos (Tetrachlorovinphos)	2.8	DNE	ND	2.5	NS	NS	2.5 UJ	NS	1/2	2.5-2.5	1.9	0.89286	0
	Zinc	11,000	DNE	39.8	14.7 J	NS	NS	5.0 U	NS	1/2	14.7-14.7	8.6	0.00134	0
	bis(2-Ethylhexyl)phthalate (BEHP)	4.8	DNE	ND	5.0 J	NS	NS	10.0 U	NS	1/2	5.0-5.0	5	1.04167	0
	R Factor/Weighted MCL												**28.534**	**0.0965**

Table A-2
Area B (SWMU 3 and 40)
Fluvial Deposits Groundwater Monitoring Results (μg/L)

Well ID	Analyte	RBC	MCL	RC	Initial Eve.	Conf. Eve.	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
0GMG07MF (GM-7)	Acetone	3,700	DNE	ND	34.0 J	NS	10.0 U	10.0 UJ	NS	1/3	34.0-34.0	14.7	0.00919	0
	Arsenic	3.5	50	3.5	2.0 J	NS	NS	3.1 J	NS	2/2	2.0-3.1	2.6	0.88571	0.062
	Barium	2,600	2,000	232	71.3 J	NS	NS	78.5 J	NS	2/2	71.3-78.5	74.9	0.03019	0.03925
	Benzene	0.36	5	ND	10.0 U	NS	1.0 J	10.0 U	NS	1/3	1.0-1.0	3.7	2.77778	0.2
	Chromium	180	100	39.8	6.0 J	NS	NS	5.0 U	NS	1/2	6.0-6.0	4.3	0.03333	0.06
	Lead	DNE	15 [a]	6.6	5.8	NS	NS	2.1 J	NS	2/2	2.1-5.8	4	0.87879	0.38667
	Zinc	11,000	DNE	39.8	18.1 J	NS	NS	5.0 U	NS	1/2	18.1-18.1	10.3	0.00165	0
	R Factor/Weighted MCL												**4.61664**	**0.74792**
SWMU 3 DPT Data[b]														
3GH0147 (3-1)					ND									
3GH0245 (3-2)					ND									
3GH0345 (3-3)					ND									
3GH0447 (3-4)					ND									
3GH0542 (3-5)					ND									
3GH0645 (3-6)					ND									
3GH0747 (3-7)					ND									
3GH0848 (3-8)					ND									

Table A-2
Area B (SWMU 3 and 40)
Fluvial Deposits Groundwater Monitoring Results (μg/L)

Well ID	Analyte	RBC	MCL	RC	Initial Eve.	Conf. Eve.	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
3GH0947 (3-9)					ND									
3GH1040 (3-10)					ND									
SWMU 40 Well and DPT Data[c]														
WL-1F					ND									
40-1					ND									
40-2					ND									
40-3					ND									
40-4					ND									
40-5					ND									
40-6					ND									
40-7					ND									
	m, p-Xylenes	12,000	10,000	ND	11								0.001	0.001
40-8	1,2,4-Trimethylbenzene	12	DNE	ND	5								0.42	NA
	Naphthalene	1,500	DNE	ND	25								0.02	NA
R Factor/Weighted MCL													**0.44**	**0.01**
40-9					ND									
40-15					ND									
40-16					ND									
40-17					ND									

Table A-2
Area B (SWMU 3 and 40)
Fluvial Deposits Groundwater Monitoring Results (μg/L)

Well ID	Analyte	RBC	MCL	RC	Initial Eve.	Conf. Eve.	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
40-18	m,p-Xylenes	12,000	10,000	ND	10								0.001	0.001
	1,2,4 Trimethylebenze	12	DNE	ND	5								0.42	NA
R Factor/Weighted MCL													**0.42**	**0.001**
40-19					ND									

Notes:

RBC — Risk-based concentration from *Risk-Based Concentration Table* (U.S. EPA, December 22, 1997).
MCL — Maximum Contaminant Level from U.S. EPA *Drinking Water Regulations and Health Advisories* (U.S.EPA, October 1996).
RC — Reference concentration (background). The RC is two times the mean concentration of a constituent detected in samples collected from background monitoring wells that are screened in the fluvial deposits.
Rfact — R factors is the cumulative RBC exceedance based on maximum detection of compound.
Mfact — M factor is the cumulative MCL exceedance based on maximum detection of compound.
ND — Non-detect
NS — Not sampled
NA — Not applicable
DNE — Does not exist
J — Estimated value because one or more quality control criteria were not met.
B — The analyte was found in the associated lab blank as well as the sample.
D — Analyte analyzed at a secondary dilution factor.
U — Analyte not detected. Value indicates method reporting limit.
a — Treatment Technology Action Level (TTAL)
b — SWMU 3 DPT data presented in the column labeled "Initial Event" was collected in November 1994.
c — SWMU 40 DPT data presented in the column labeled "Initial Event" was collected in May 1995.
One half of the detection limit has been used for "non-detects" to calculate the mean, which may result in the mean values exceeding the range of listed concentrations.

This page intentionally left blank.

Table A-3
Area C (SWMUs 5, 27, 60,and BG-5)
Fluvial Deposits Groundwater Monitoring Results (μg/L)

Well ID	Analyte	RBC	MCL	RC	Initial Eve.	Conf. Eve.	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
SWMU 5														
Well Data														
	2-Butanone (MEK)	1,900	DNE	ND	10.0 U	NS	10.0 U	11	10.0 U	1/5	11.0-11.0	7.7	0.00579	0
	Acetone	3,700	DNE	ND	10.0 U	NS	3.0 J	10.0 U	10.0 U	1/5	3.0-3.0	8.6	0.00081	0
	Barium (Ba)	2,600	2,000	232	48.6 J	NS	NS	NS	NS	1/1	48.6-48.6	48.6	0.01869	0.0243
005G01UF	Chloromethane	1.4	DNE	NA	10.0 UJ	NS	10.0 U	5.0 J	10.0 U	1/5	5.0-5.0	5	3.57143	0
	Lead	DNE	15 [a]	6.6	32.8 J	NS	NS	NS	NS	1/1	32.8-32.8	32.8	4.9697	2.18667
	Zinc	11,000	DNE	39.8	6.4 J	NS	NS	NS	NS	1/1	6.4-6.4	6.4	0.00058	0
	R Factor/Weighted MCL												**8.567**	**2.21097**
	2-Butanone (MEK)	1,900	DNE	ND	10.0 U	NS	27	10.0 U	10.0 U	1/5	27.0-27.0	10.9	0.01421	0
005G02UF	Barium	2,600	2,000	232	112.0 J	NS	NS	NS	NS	1/1	112.0-112.	112	0.04308	0.056
	Cadmium	18	5	3.9	5.4 J	NS	NS	NS	NS	1/1	5.4-5.4	5.4	0.3	1.08
	R Factor/Weighted MCL												**0.35729**	**1.136**
005G03UF	Barium	2,600	2,000	232	61.4 J	NS	NS	NS	NS	1/1	61.4-61.4	61.4	0.02362	0.0307
	R Factor/Weighted MCL												**0.02362**	**0.0307**
	Acetone	3,700	DNE	ND	10.0 UJ	NS	54	10.0 U	10.0 U	1/5	54.0-54.0	18.8	0.01459	0
005G04UF	Barium	2,600	2,000	232	50.8 J	NS	NS	NS	NS	1/1	50.8-50.8	50.8	0.01954	0.0254
	Carbon tetrachloride	0.16	5	ND	10.0 U	NS	10.0 U	10.0 U	1.0 J	2/5	1.0-1.2	3.4	7.5	0.24
	R Factor/Weighted MCL												**7.53413**	**0.2654**
	Barium	2,600	2,000	232	214	NS	NS	NS	NS	1/1	214.0-214.	214	0.08231	0.107
005G05LF	Cobalt	2,200	DNE	16.2	6.9 J	NS	NS	NS	NS	1/1	6.9-6.9	6.9	0.00314	0
	Copper	1,500	1,300	5.6	6.0 J	NS	NS	NS	NS	2/2	6.0-6.0	6	0.004	0.00462
	Lead	DNE	15 [a]	6.6	5.4 J	NS	NS	NS	NS	1/1	5.4-5.4	5.4	0.81818	0.36
005G05LF	Zinc	11,000	DNE	39.8	12.5 J	NS	NS	NS	NS	1/1	12.5-12.5	12.5	0.00114	0
	R Factor/Weighted MCL												**0.90877**	**0.47162**

Table A-3
Area C (SWMUs 5, 27, 60,and BG-5)
Fluvial Deposits Groundwater Monitoring Results (μg/L)

Well ID	Analyte	RBC	MCL	RC	Initial Eve.	Conf. Eve.	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
005G4AUF	Barium	2,600	2,000	232	76.8 J	NS	NS	NS	NS	1/1	76.8-76.8	76.8	0.02954	0.0384
	Carbon tetrachloride	0.16	5	ND	3.0 J	NS	5.0 J	4.0 J	6.0 J	4/4	3.0-6.0	4.5	37.5	1.2
	Cobalt	2,200	DNE	16.2	8.7 J	NS	NS	NS	NS	1/1	8.7-8.7	8.7	0.00395	0
	bis(2-Ethylhexyl)phthalate (BEHP)	4.8	DNE	ND	3.0 J	NS	NS	NS	NS	1/1	3.0-3.0	3	0.625	0
	R Factor/Weighted MCL												**38.1585**	**1.2384**
005G4BUF	Barium	2,600	2,000	232	82.1 J	NS	NS	NS	NS	1/1	82.1-82.1	82.1	0.03158	0.04105
	Carbon tetrachloride	0.16	5	ND	4.0 J	NS	5.0 J	4.0 J	10.0 J	4/4	4.0-10.0	5.8	62.5	2
	Chloroform	0.15	100	ND	10.0 U	NS	10.0 U	10.0 UJ	1.0 J	1/4	1.0-1.0	4	6.66667	0.01
	Cobalt	2,200	DNE	16.2	9.4 J	NS	NS	NS	NS	1/1	9.4-9.4	9.4	0.00427	0
	Nitrobenzene	3.4	DNE	ND	1.0 J	NS	NS	NS	NS	1/1	1.0-1.0	1	0.29412	0
	R Factor/Weighted MCL												**69.4966**	**2.05105**
DPT Data[b]														
5GH0145 (5-1)					ND									
5GH0243 (5-2)					ND									
5GH0344 (5-3)					ND									
5GH0446 (5-4)					ND									
5GH0550 (5-5)					ND									
5GH0647 (5-6)					ND									

Table A-3
Area C (SWMUs 5, 27, 60,and BG-5)
Fluvial Deposits Groundwater Monitoring Results (μg/L)

Well ID	Analyte	RBC	MCL	RC	Initial Eve.	Conf. Eve.	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
5GH0744 (5-7)	Benzene	0.36	5	ND	5.7									
	Naphthalene	1,500	DNE	ND	51									
	Xylene	12,000	10,000	NA	16									
5GH0854 (5-8)					ND									
5GH0943 (5-9)					ND									
5GH1040 (5-10)					ND									
5GH1047 (5-10)					ND									
5GH1149 (5-11)					ND									
5GH1240 (5-12)					ND									
5GH1326 (5-13)					ND									
5GH1443 (5-14)					ND									
SWMU 27														
DPT Data[c]														
027G000144 (27-1)					ND									
027G000244 (27-2)					ND									
027G000545 (27-5)					ND									
027G000644 (27-6)					ND									

Table A-3
Area C (SWMUs 5, 27, 60,and BG-5)
Fluvial Deposits Groundwater Monitoring Results (μg/L)

Well ID	Analyte	RBC	MCL	RC	Initial Eve.	Conf. Eve.	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
027G000844 (27-8)					ND									
027G000944 (27-9)					ND									
SWMU 60														
Well Data														
060G01LF	Acetone	3,700	DNE	ND	14.0 UJ	NS	10.0 U	33	10.0 U	1/4	33.0-33.0	12.5	0.00892	0
	Barium	2,600	2,000	232	210	NS	NS	NS	NS	1/1	210.0-210.	210	0.08077	0.105
	Cobalt	2,200	DNE	16.2	8.4 J	NS	NS	NS	NS	1/1	8.4-8.4	8.4	0.00382	0
	R Factor/Weighted MCL												**0.09351**	**0.105**
060G02LF	Barium	2,600	2,000	232	736	NS	NS	NS	NS	1/1	736.0-736.	736	0.28308	0.368
	Chloroform	0.15	100	ND	10.0 U	NS	1.0 J	10.0 U	10.0 U	1/4	1.0-1.0	4	6.66667	0.01
	Lead	DNE	15 [a]	6.6	4.9 J	NS	NS	NS	NS	1/1	4.9-4.9	4.9	0.74242	0.32667
	R Factor/Weighted MCL												**7.69217**	**0.70467**
060G03LF	Barium	2,600	2,000	232	105.0 J	NS	NS	NS	NS	1/1	105.0-105.	105	0.04038	0.0525
	Cobalt	2,200	DNE	16.2	5.0 J	NS	NS	NS	NS	1/1	5.0-5.0	5	0.00227	0
	Copper	1,500	1,300	5.6	6.4 J	NS	NS	NS	NS	2/2	6.4-6.4	6.4	0.00427	0.00492
	Lead	DNE	15 [a]	6.6	10.5 J	NS	NS	NS	NS	1/1	10.5-10.5	10.5	1.59091	0.7
	R Factor/Weighted MCL												**1.63783**	**0.75742**
060G04LF	Barium (Ba)	2,600	2,000	232	73.7 J	NS	NS	NS	NS	1/1	73.7-73.7	73.7	0.02835	0.03685
	R Factor/Weighted MCL												**0.02835**	**0.03685**
DPT Data [b]														
60GH0144 (60-1)					ND									
60GH0232 (60-2)					ND									

Table A-3
Area C (SWMUs 5, 27, 60,and BG-5)
Fluvial Deposits Groundwater Monitoring Results (μg/L)

Well ID	Analyte	RBC	MCL	RC	Initial Eve.	Conf. Eve.	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
60GH0247 (60-2)					ND									
60GH0348 (60-3)					ND									
60GH0547 (60-5)					ND									
60GH0747 (60-7)					ND									
60GH0846 (60-8)					ND									
Background Well Cluster5														
OBGG05UF	Tetrachloroethene	1.1	5	ND	17	19							17.3	
0BGGO5LF	Tetrachloroethene	1.1	5	ND	27	27							24.5	
0BGG14MF					ND									
DPT Data[d]														
BG5G004 (BG5-1)					ND									
BG5G005 (BG5-2)					ND									
BG5G006 (BG5-3)	Tetrachloroethene	1.1	5	ND	7.7								7	1.54
BG5G07 (BG5-4)					ND									
007G00J1 (BG5-5)					ND									
007G00J2 BG5-6)					ND									

Table A-3
Area C (SWMUs 5, 27, 60,and BG-5)
Fluvial Deposits Groundwater Monitoring Results (μg/L)

Well ID	Analyte	RBC	MCL	RC	Initial Eve.	Conf. Eve.	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
007G00J3 (BG5-7)	Tetrachloroethene	1.1	5	ND	23.7								**21.5**	**4.74**
	Benzene	0.36	5	ND	5.7								**15.8**	**1.14**
	Chlorobenzene	39	NA	ND	5.1								**0.13**	**-**
	Ethylbenzene	1,300	NA	NA	1.1									
	Total												**37.4**	**5.9**
007G00J4 (BG5-8)	Tetrachloroethene	1.1	5	ND	729								**663**	**145.8**
	Trichloroethene	1.6	5	ND	5.5								**3.4**	**1.1**
	Total												**666.4**	**1.1**
007G00J5 (BG5-9)	Tetrachloroethene	1.1	5	ND	33.6								**30.5**	**6.72**
007G00J6 (BG5-10)					ND									

Notes:

RBC — *Risk-based Concentration Table* (U.S. EPA Region, December 22, 1997).
MCL — Maximum Contaminant Level from *Drinking Water Regulations and Health Advisories* (October 1996, USEPA Office of Water, Drinking Water Regulations and Health Advisories).
RC — Rreference concentration (background). The RC is two times the mean concentration of a constituent detected in samples collected from background monitoring wells that are screened in the fluvial deposits.
Rfact — R factors are the cumulative RBC exceedances based on maximum detection of compounds.
Mfact — M factor is the cumulative MCL exceedance based on maximum detection of compounds.
ND — Non-detect
NS — Not sampled
NA — Not applicable
DNE — Does not exist.
J — Estimated value because one or more quality control criteria were not met.
B — The analyte was found in the associated lab blank as well as the sample.
D — Analyte analyzed at a secondary dilution factor.
U — Analyte not detected. Value indicates method reporting limit.
a — Treatment Technology Action Level (TTAL)
b — SWMU 5 and 60 DPT data presented in the column labeled "Initial Event" were collected in November 1994.
c — SWMU 27 DPT data presented in the column labeled "Initial Event" were collected in June 1995.
d — BG-5 DPT data presented in the column labeled "Initial Event" were collected in June 1995 (BG-1 through BG-4), October 1995 (BG-10), and February 1997 (BG-5 through BG-9).
One half of the detection limit has been used for “non-detects” to calculate the mean, which may result in the mean values exceeding the range of listed concentrations.

Table A-4
Area D (North Fuel Farm)
Fluvial Deposits Groundwater Monitoring Results (μg/L)

Well ID	Analyte	RBC	MCL	RC	Init. Event	Conf. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
North Fuel Farm														
DPT Data[a]														
1FF46[A]					ND									
2FF46[B]	Trichloroethene	1.1	5	ND	6.8								6.2	1.4
NFFS001														
NFFS002					ND									
NFFS003	1,1 dichlorethene	0.044	7	ND	2.2								50	0.3
NFFS004					ND									
NFFS005					ND									
NFFS006					ND									
NFFS007					ND									
NFFS008					ND									
NFFS009					ND									
NFFS010					ND									
NFFS011					ND									
NFFS012					ND									
NFFS013					ND									
NFFS014					ND									
NFFS015					ND									
NFFS016					ND									

Table A-4
Area D (North Fuel Farm)
Fluvial Deposits Groundwater Monitoring Results ($\mu g/L$)

Well ID	Analyte	RBC	MCL	RC	Init. Event	Conf. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
NFFS025					ND									
NFFS026					ND									

Notes:
RBC — *Risk-Based Concentration Table* (U.S. EPA, December 22, 1997).
MCL — Maximum Contaminant Level from U.S.EPA *Drinking Water Regulations and Health Advisories* (U.S. EPA, October 1996).
RC — Reference concentration (background). The RC is two times the mean concentration of a constituent detected in samples collected from background monitoring wells that are screened in the fluvial deposits.
Rfact — R factor is the cumulative RBC exceedance based on maximum detection of compounds.
Mfact — M factor is the cumulative MCL exceedance based on maximum detection of compounds.
ND — Non-detect
a — DPT data presented in the column labeled "Initial Event" represents the DPT collected at the North Fuel Farm.
One half of the detection limit has been used for "non-detects" to calculate the mean, which may result in the mean values exceeding the range of listed concentrations.

Table A-5
Area E (SWMUs 1 and 62) Groundwater Monitoring and DPT Results (μg/L)
Organics, Inorganics, and R Factors

Well ID	Analyte	RBC	MCL	RC	Initial Even.	Confir. Even.	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
SWMU 1														
DPT Data[a]														
1GH0135 (1-1)					ND									
1GH0150 (1-1)					ND									
1GH0250 (1-2)					ND									
1GH0350 (1-3)					ND									
1GH0552 (1-5)					ND									
SWMJ 62														
62GH0141 (62-1)					ND									
62G04042 (62-4)					ND									
62G05041 (62-5)					ND									
62G06038 (62-6)					ND									

Notes:
RBC — Risk-based concentration from *Risk-Based Concentration Table* (U.S.EPA, December 22, 1997).
MCL — Maximum Contaminant Level from U.S. EPA *Drinking Water Regulations and Health Advisories* (U.S.EPA, October 1996).
RC — Reference concentration (background). The RC is two times the mean concentration of a constituent detected in samples collected from background monitoring wells that are screened in the fluvial deposits.
Rfact — R factor is the cumulative RBC exceedance based on maximum detection of compounds.
Mfact — M factor is the cumulative MCL exceedance based on maximum detection of compounds.
ND — Non-detect
a — SWMU 1 and 62 DPT data presented in the columns labeled "Initial event" correspond with DPT sampling events conducted in November 1995 and May 1995, respectively.
One half of the detection limit has been used for "non-detects" to calculate the mean, which may result in the mean values exceeding the range of listed concentrations.

This page intentionally left blank.

Table A-6
Area F (SWMU 8)
Fluvial Deposits Groundwater Monitoring Results (μg/L)

Well ID	Analyte	RBC	MCL	RC	Init. Event	Conf. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
SWMU 8														
Well Data														
	4-Methyl-2-Pentanone (MIBK)	2,900	DNE	ND	10.0 U	NS	5.0 J	10.0 U	10.0 U	¼	5.0-5.0	5	0.00172	0
	Acetone	3,700	DNE	ND	10.0 U	NS	10.0 U	32	10.0 U	1/4	32.0-32.0	11.8	0.00865	0
	Barium	2,600	2,000	232	65.6 J	NS	NS	NS	53.1 J	2/2	53.1-65.6	59.4	0.02523	0.0328
	Beryllium	0.016	4	ND	1.0 U	NS	NS	NS	0.1 J	1/2	0.1-0.1	0.3	4.375	0.0175
	Chromium	180	100	39.8	5.0 U	NS	NS	NS	12.3	1/2	12.3-12.3	7.4	0.06833	0.123
	Cobalt	2,200	DNE	16.2	5.0 U	NS	NS	NS	2.5 J	1/2	2.5-2.5	2.5	0.00114	0
008G01FL	Lead	DNE	15 [a]	6.6	3.6	NS	NS	NS	1.5 U	1/2	3.6-3.6	2.2	0.54545	0.24
	Nickel	730	100	33.4	15.0 U	NS	NS	NS	25.4 J	1/2	25.4-25.4	16.5	0.03479	0.254
	Vanadium	260	DNE	17.4	4.0 U	NS	NS	NS	2.3 J	1/2	2.3-2.3	2.2	0.00885	0
	Zinc	11,000	DNE	39.8	11.0 J	NS	NS	NS	21.5 U	1/2	11.0-11.0	10.9	0.001	0
	bis(2-Ethylhexyl)phthalate (BEHP)	4.8	DNE	ND	8.0 J	NS	NS	NS	10.0 U	1/2	8.0-8.0	6.5	1.66667	0
	R Factor/Weighted MCL												**6.73683**	**0.6673**
	Acetone	3,700	DNE	ND	10.0 U	NS	NS	19,000	10.0 U	1/3	19000.0-19	6,336.7	5.13514	0
	Barium	2,600	2,000	232	74.3 J	NS	NS	NS	102.0 J	2/2	74.3-102.0	88.2	0.03923	0.051
	Beryllium	0.016	4	ND	1.0 U	NS	NS	NS	0.7 J	1/2	0.7-0.7	0.6	41.875	0.1675
008G02FL	Chromium	180	100	39.8	5.0 U	NS	NS	NS	17.2	1/2	17.2-17.2	9.9	0.09556	0.172
	Cobalt	2,200	DNE	16.2	5.0 U	NS	NS	NS	8.2 J	1/2	8.2-8.2	5.4	0.00373	0
	Lead	DNE	15 [a]	6.6	3.8	NS	NS	NS	7.7 U	1/2	3.8-3.8	3.8	0.57576	0.25333
	Nickel	730	100	33.4	15.0 U	NS	NS	NS	16.6 J	1/2	16.6-16.6	12.1	0.02274	0.166

Table A-6
Area F (SWMU 8)
Fluvial Deposits Groundwater Monitoring Results (μg/L)

Well ID	Analyte	RBC	MCL	RC	Init. Event	Conf. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
008G02FL	Vanadium	260	DNE	17.4	4.0 U	NS	NS	NS	25.0 J	1/2	25.0-25.0	13.5	0.09615	0
	Zinc	11,000	DNE	39.8	8.3 J	NS	NS	NS	22.3 U	1/2	8.3-8.3	9.7	0.001	0
	R Factor/Weighted MCL												**47.8441**	**0.80983**
008G03FL	Acetone	3,700	DNE	ND	10.0 U	NS	21.0 U	10.0 U	42	1/4	42.0-42.0	15.6	0.01135	0
	Barium	2,600	2,000	232	57.4 J	NS	NS	NS	56.0 J	2/2	56.0-57.4	56.7	0.02208	0.0287
	Chromium	180	100	39.8	5.7 J	NS	NS	NS	4.8 U	1/2	5.7-5.7	4.1	0.03167	0.057
	Copper	1,500	1,300	5.6	5.8 J	NS	NS	NS	15.8 U	2/4	5.8-5.8	6.9	0.00387	0.00446
	Lead	DNE	15 [a]	6.6	2.7 J	NS	NS	NS	2.6 U	1/2	2.7-2.7	2	0.40909	0.18
	R Factor/Weighted MCL												**0.47806**	**0.27016**
008G04FL	Barium	2,600	2,000	232	53.3 J	NS	NS	NS	55.2 J	2/2	53.3-55.2	54.3	0.02123	0.0276
	Beryllium	0.016	4	ND	1.0 U	NS	NS	NS	0.1 J	1/2	0.1-0.1	0.3	5	0.02
	Chromium	180	100	39.8	5.0 U	NS	NS	NS	7.3 J	1/2	7.3-7.3	4.9	0.04056	0.073
	Cobalt	2,200	DNE	16.2	5.0 U	NS	NS	NS	2.9 J	1/2	2.9-2.9	2.7	0.00132	0
	Copper	1,500	1,300	5.6	5.2 J	NS	NS	NS	14.4 U	2/4	5.2-5.2	6.2	0.00347	0.004
	Lead	DNE	15 [a]	6.6	33.2 J	NS	NS	NS	1.5 U	1/2	33.2-33.2	17	5.0303	2.21333
	Nickel	730	100	33.4	15.0 U	NS	NS	NS	9.8 J	1/2	9.8-9.8	8.7	0.01342	0.098
	Vanadium	260	DNE	17.4	4.0 U	NS	NS	NS	5.0 J	1/2	5.0-5.0	3.5	0.01923	0
	R Factor/Weighted MCL												**10.1295**	**2.43593**
0GMG11FL (GM-11)	Arsenic	3.5	50	ND	2.0 UJ	NS	NS	NS	1.5 J	1/2	1.5-1.5	1.3	0.42857	0.03
	Barium	2,600	2,000	232	50.1 J	NS	NS	NS	38.9 J	2/2	38.9-50.1	44.5	0.01927	0.02505
	Beryllium	0.016	4	ND	1.0 U	NS	NS	NS	0.2 J	1/2	0.2-0.2	0.3	10.625	0.0425
	Chromium	180	100	39.8	8.2 J	NS	NS	NS	23.3	2/2	8.2-23.3	15.8	0.12944	0.233
	Cobalt	2,200	DNE	16.2	5.0 U	NS	NS	NS	2.9 J	1/2	2.9-2.9	2.7	0.00132	0

Table A-6
Area F (SWMU 8)
Fluvial Deposits Groundwater Monitoring Results (μg/L)

Well ID	Analyte	RBC	MCL	RC	Init. Event	Conf. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
0GMG11FL (GM-11)	Copper	1,500	1,300	5.6	9.7 J	NS	NS	NS	11.4 U	2/4	9.7-9.7	7.7	0.00647	0.00746
	Lead	DNE	15 [a]	6.6	23.4 J	NS	NS	NS	1.6 U	1/2	23.4-23.4	12.1	3.54545	1.56
	Nickel	730	100	33.4	15.0 U	NS	NS	NS	26.3 J	1/2	26.3-26.3	16.9	0.03603	0.263
	Vanadium	260	DNE	17.4	11.4 J	NS	NS	NS	8.6 J	2/2	8.6-11.4	10	0.04385	0
	Zinc	11,000	DNE	39.8	12.2 J	NS	NS	NS	22.4 U	1/2	12.2-12.2	11.7	0.00111	0
	bis(2-Ethylhexyl)phthalate (BEHP)	4.8	DNE	ND	11	NS	NS	NS	10.0 U	1/2	11.0-11.0	8	2.29167	0
	R Factor/Weighted MCL												**17.1282**	**2.16101**
DPT Data [b]														
8GH0129 (8-1)					ND									
8GH0226 (8-2)					ND									
8GH0330 (8-3)					ND									
8GH0426 (8-4)					ND									
8GH0527 (8-5)					ND									
8GH0632 (8-6)					ND									
8GH0733 (8-7)					ND									
8GH0827 (8-8)					ND									

Table A-6
Area F (SWMU 8)
Fluvial Deposits Groundwater Monitoring Results (µg/L)

Well ID	Analyte	RBC	MCL	RC	Init. Event	Conf. Event	Event 1	Event 2	Event 3	Freq	Range	Mean	R Fact	M Fact
8GH00955 (8-9)					ND									
8GH1027 (8-10)					ND									
8GH1126 (8-11)					ND									

Notes:

RBC — Risk-based concentration from *Risk-Based Concentration Table* (U.S. EPA, December 22, 1997).
MCL — Maximum Contaminant Level from *Drinking Water Regulations and Health Advisories* (U.S. EPA, October 1996).
RC — Reference concentrations (background). The RC is two times the mean concentration of a constituent detected in samples collected from background monitoring wells that are screened in the fluvial deposits.
Rfact — R factor is the cumulative RBC exceedance based on maximum detection of constituents.
Mfact — M factor is the cumulative MCL exceedance based on maximum detection of constituents.
ND — Non-detect
NS — Not sampled
NA — Not applicable
DNE — Does not exist
J — Estimated value because one or more quality control criteria were not met.
B — The analyte was found in the associated lab blank as well as the sample.
D — Analyte analyzed at a secondary dilution factor.
U — Analyte not detected. Value indicates method reporting limit.
a — Treatment Technology Action Level (TTAL)
b — SWMU 8 DPT data presented in the column labeled "Initial Event" were collected in November 1994.
One half of the detection limit has been used for "non-detects" to calculate the mean, which may result in the mean values exceeding the range of listed concentrations.

Appendix B

Boring, Well Construction, and Geophysical Logs

- Loess Wells
- Upper Fluvial Wells
- Lower Fluvial Wells
- Cockfield Formation Wells

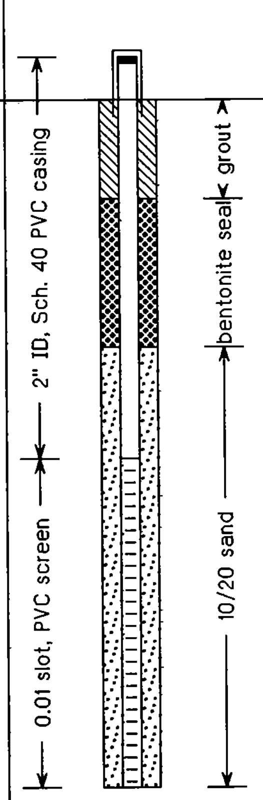
Loess
Boring/Well Construction Logs

Monitoring Well 007G01LS

Project: *NSA Memphis*	Location: *Millington, TN. SWMU#7 – Building N-126*
Project No.: *0094*	Surface Elevation: *283.15 feet msl*
Started at *1015 on 2-07-95*	TOC Elevation: *284.74 feet msl*
Completed at *on 2-11-95*	Depth to Groundwater: *20.0 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *263.64 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *21.4 feet*
Geologist: *Ben Brantley*	Well Screen: *10.9 to 20.9 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Clayey silt, grayish blue green, moist. Petroleum odor.	
5			1	80	BG				
								Clayey silt, moderate brown, medium stiff.	
10							ML		
								Clayey silt, moderate brown to dark yellowish brown, mottled pale yellowish brown.	
15			2	100	BG				
								Clayey silt, light brown to reddish brown, stiff, dry.	
20								Clayey silt, moderate brown, stiff.	
			3	100	BG				262.2
								Log information taken from the boring for the Cockfield well at SWMU#7 site 1.	
25									
30									
35									
40									

WELL DIAGRAM

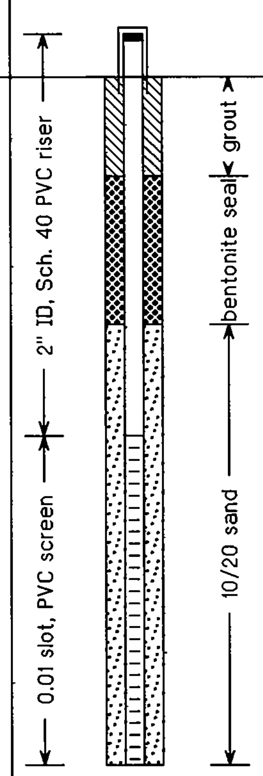


Monitoring Well 007G03LS

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.81 feet msl*
Started at *1630 on 2-07-95*	TOC Elevation: *283.47 feet msl*
Completed at *1500 on 2-11-95*	Depth to Groundwater: *13.10 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *270.37 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *21.4 feet*
Geologist: *Ben Brantley*	Well Screen: *10.9 to 20.9 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Clayey silt, moderate brown to moderate yellowish brown, moist.	
5			1	40	BG				
10			2	120	BG		ML		
15			3	100	BG			Clayey silt, olive black, moist, soft.	
20			4	90	BG				262.4
								Log information taken from the boring for the Cockfield well at SWMU#7 Site 3.	
25									
30									
35									
40									

WELL DIAGRAM



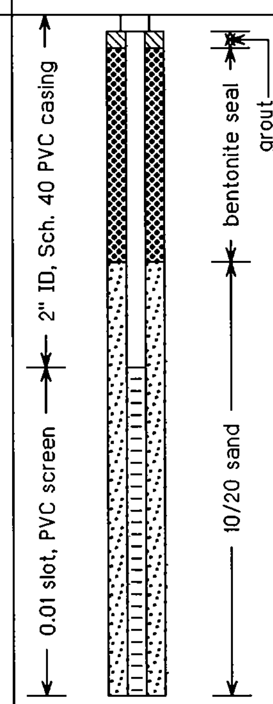
Monitoring Well 007G05LS

EnSafe (SM)

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *282.79 feet msl*
Started at *on 2-09-95*	TOC Elevation: *282.43 feet msl*
Completed at *on 2-09-95*	Depth to Groundwater: *feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *20.76 feet*
Geologist: *Jack Carmichael*	Well Screen: *10.26 to 20.26 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
0–4			1	75	BG			Clayey silt, moderate brown to yellowish brown, trace of organics.	
4–10			2	60	BG		ML		
10–15			3	100	BG			Clayey silt, dark yellowish brown, stiff, hard.	
15–20.76			4	90	BG				262.1
20.76–40								Log information taken from the boring for the Cockfield well at SWMU#7 Site 5.	

WELL DIAGRAM



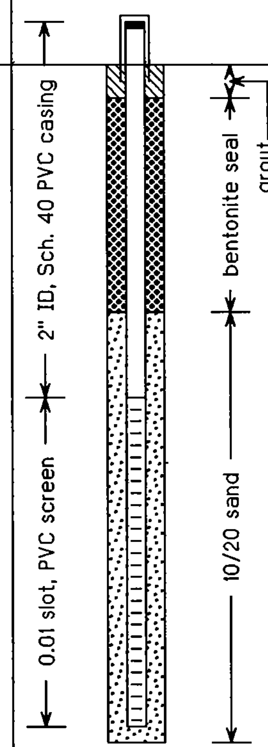
EnSafe (SM)

Monitoring Well 007G06LS

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *284.17 feet msl*
Started at *0820 on 2-10-95*	TOC Elevation: *286.37 feet msl*
Completed at *1010 on 2-10-95*	Depth to Groundwater: *12.49 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *273.88 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *20.6 feet*
Geologist: *Ben Brantley*	Well Screen: *10.1 to 20.1 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
0								Fill and brick.	
3			1	66	BG			Clayey silt, moderate yellowish brown, mottled with yellow gray.	
10			2	70	BG		ML		
15			3	70	BG				
20.6			4	60	BG			Log information taken from the boring for the Cockfield well at SWMU#7 site 6.	263.6

WELL DIAGRAM



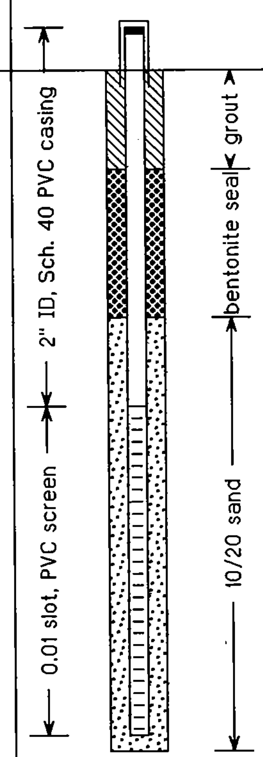
EnSafe (SM)

Monitoring Well 007G07LS

Project: NSA Memphis	Location: Millington, TN. Building N-126
Project No.: 0094	Surface Elevation: 282.47 feet msl
Started at 1750 on 2-10-95	TOC Elevation: 284.44 feet msl
Completed at on 2-10-95	Depth to Groundwater: 11.0 feet Measured: 3/31/95
Drilling Method: Rotasonic	Groundwater Elevation: 273.44 feet msl
Drilling Company: North Star Drilling	Total Depth: 20.7 feet
Geologist: Ben Brantley	Well Screen: 10.2 to 20.2 feet

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Clayey silt, moderate yellowish brown, organics, mottled with yellowish gray silt.	
5			1	125	BG				
10			2	70	BG		ML		
15			3	80	BG			Clayey silt, light olive gray to olive brown, soft, moist.	
20			4	65	BG			Log information taken from the boring for the Cockfield well at SWMU#7 site 7.	261.8
25									
30									
35									
40									

WELL DIAGRAM



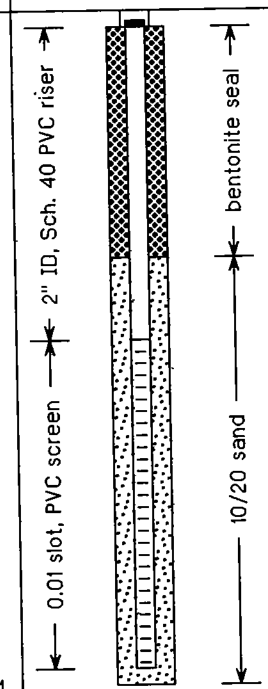
Monitoring Well 007G09LS

EnSafe (SM)

Project: NSA Memphis	Location: Millington, TN. Building N-126
Project No.: 0094	Surface Elevation: 282.89 feet msl
Started at 1550 on 2-11-95	TOC Elevation: 282.54 feet msl
Completed at on 2-25-95	Depth to Groundwater: 13.30 feet Measured: 3/31/95
Drilling Method: Rotasonic	Groundwater Elevation: 269.24 feet msl
Drilling Company: North Star Drilling	Total Depth: 20.5 feet
Geologist: Ben Brantley	Well Screen: 10.0 to 20.0 feet

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
0								Clayey silt, moderate brown with yellow gray streaks, moist, soft.	
5			1	100	BG				
10			2	70	BG		ML		
15			3	100	BG			Silty clay, reddish brown, stiff and plastic.	
20								Clayey silt, light brown with clay inclusions.	262.4
								Log information taken from the boring for the Cockfield well at SWMU#7 site 9.	
25									
30									
35									
40									

WELL DIAGRAM



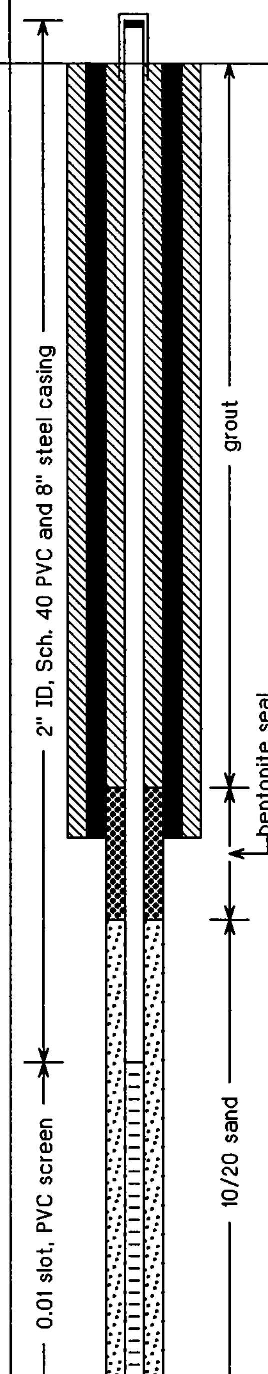
Upper Fluvial Deposits
Boring/Well Construction Logs

Monitoring Well 007G01UF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.61 feet msl*
Started at *1015 on 2-07-95*	TOC Elevation: *285.00 feet msl*
Completed at *on 2-25-95*	Depth to Groundwater: *27.93 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.06 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *40.8 feet*
Geologist: *Ben Brantley*	Well Screen: *30.3 to 40.3 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Clayey silt, grayish blue green, moist. Petroleum odor.	
5			1	80	BG				
								Clayey silt, moderate brown, medium stiff.	
10									
							ML	Clayey silt, moderate brown to dark yelllowish brown, mottled pale yellowish brown.	
15			2	100	BG				
								Clayey silt, light brown to reddish brown, stiff, dry.	
20								Clayey silt, moderate brown, stiff.	
25			3	100	BG				258.6
							SC	Clayey sand, fine to medium, dark yellowish brown to light brown. Contact of Fluvial Deposits (26'-70') estimated at 26'.	
30								Medium-grained sand (30-40.8')	253.6
35			4	95	BG		SP		
40									

WELL DIAGRAM



EnSafe (SM)

Monitoring Well 007G01UF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.61 feet msl*
Started at *1015 on 2-07-95*	TOC Elevation: *285.00 feet msl*
Completed at *on 2-25-95*	Depth to Groundwater: *27.93 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.06 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *40.8 feet*
Geologist: *Ben Brantley*	Well Screen: *30.3 to 40.3 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)	WELL DIAGRAM
							SP	Log information taken from the boring for the Cockfield well at SWMU#7 site 1.	242.8	
45										
50										
55										
60										
65										
70										
75										
80										

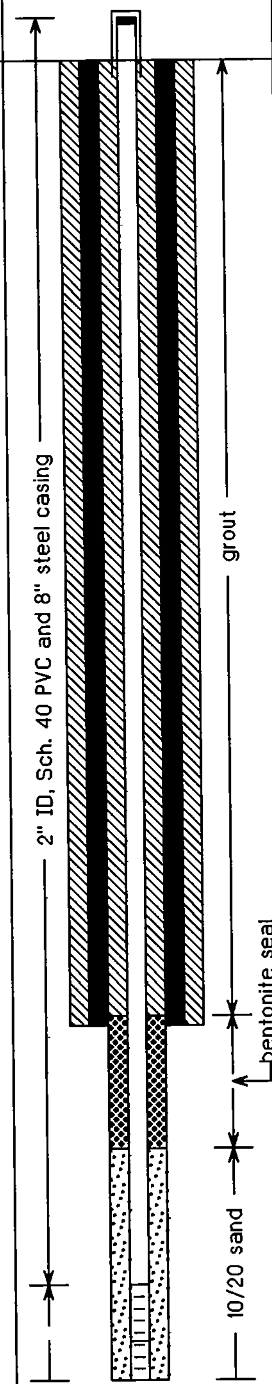
Monitoring Well 007G03UF

EnSafe

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.72 feet msl*
Started at *1630 on 2-07-95*	TOC Elevation: *283.26 feet msl*
Completed at *1500 on 2-13-95*	Depth to Groundwater: *25.25 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.00 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *47.6 feet*
Geologist: *Ben Brantley*	Well Screen: *37.1 to 47.1 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
0								Clayey silt, moderate brown to moderate yellowish brown, moist.	
5			1	40	BG				
10			2	120	BG				
15			3	100	BG		ML	Clayey silt, olive black, moist, soft.	
20			4	90	BG			Clayey silt, dark yellowish brown, medium stiff.	
25			5	90	BG			Clayey silt, moderate brown with yellow gray silt, organics.	
30			6	100	BG			Clayey silt with sand, moderate brown. Contact of Fluvial Deposits estimated at 32'. Silty clayey sand, yellowish orange to yellowish brown.	253.7
35			7	100	BG		SC	Silty sand, yellowish orange to reddish brown, fine to medium grained.	
40			8	120	BG				

WELL DIAGRAM

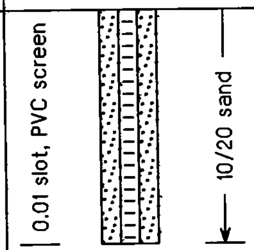


Monitoring Well 007G03UF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.72 feet msl*
Started at *1630 on 2-07-95*	TOC Elevation: *283.26 feet msl*
Completed at *1500 on 2-13-95*	Depth to Groundwater: *25.25 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.00 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *47.6 feet*
Geologist: *Ben Brantley*	Well Screen: *37.1 to 47.1 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
							SC	Sand, yellowish gray, fine. Sand, medium, yellowish orange to yellowish brown.	
45			9	120	BG				238.7
							GP	Sand, medium to coarse, grayish-orange to yellow gray, with gravels.	236.1
								Log information taken from the boring for the Cockfield well at SWMU#7 Site 3.	
50									
55									
60									
65									
70									
75									
80									

WELL DIAGRAM

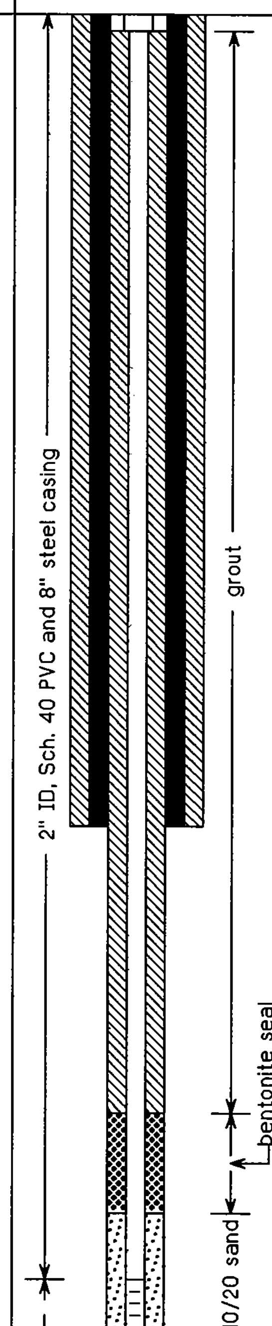


Monitoring Well 007G05UF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *282.75 feet msl*
Started at *on 2-09-95*	TOC Elevation: *282.43 feet msl*
Completed at *on 2-22-95*	Depth to Groundwater: *24.95 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.48 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *48.76 feet*
Geologist: *Jack Carmichael*	Well Screen: *38.3 to 48.3 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Clayey silt, moderate brown to yellowish brown, trace of organics.	
5			1	75	BG				
10			2	60	BG				
15			3	100	BG		ML	Clayey silt, dark yellowish brown, stiff, hard.	
20			4	90	BG				
25									
30			5	90	BG				250.2
35			6	90	BG		SC	Sandy clay, fine, medium light brown, soft, wet. Contact of Fluvial Deposits estimated at 33'. Silty sand, medium, light brown, grayish orange to yellow gray.	
40									

WELL DIAGRAM

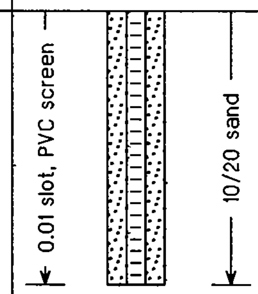


Monitoring Well 007G05UF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *282.75 feet msl*
Started at *on 2-09-95*	TOC Elevation: *282.43 feet msl*
Completed at *on 2-22-95*	Depth to Groundwater: *24.95 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.48 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *48.76 feet*
Geologist: *Jack Carmichael*	Well Screen: *38.3 to 48.3 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
45			7	60	BG		SC	Silty sand, medium, yellowish orange to light brown.	233.9
50								Log information taken from the boring for the Cockfield well at SWMU#7 Site 5.	
55									
60									
65									
70									
75									
80									

WELL DIAGRAM



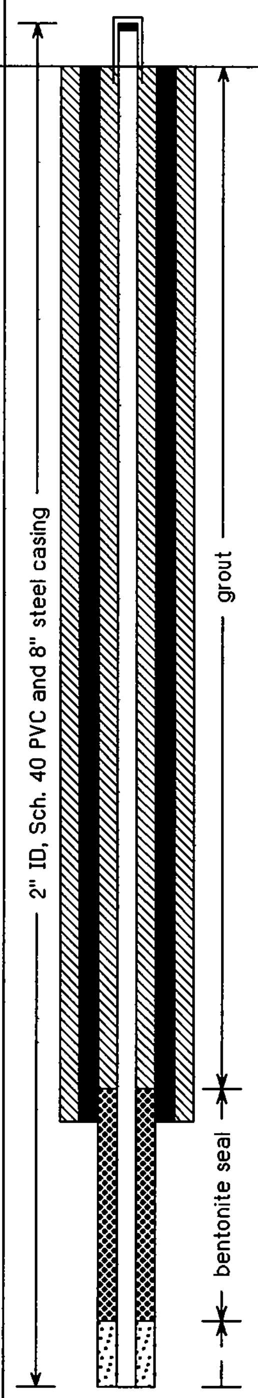
Monitoring Well 007G06UF

EnSafe (SM)

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *284.12 feet msl*
Started at *0820 on 2-10-95*	TOC Elevation: *286.48 feet msl*
Completed at *1010 on 2-22-95*	Depth to Groundwater: *37.00 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *249.48 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *50.0 feet*
Geologist: *Ben Brantley*	Well Screen: *40 to 50 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Fill and brick.	
			1	66	BG			Clayey silt, moderate yellowish brown, mottled with yellow gray.	
5									
10			2	70	BG				
15			3	70	BG				
							ML		
20									
25			4	60	BG			Clayey silt, olive brown to olive gray, hard, stiff.	
								Clayey silt, light brown to yellowish brown, medium stiff.	
30									
			5	85	BG				
								Silty clayey sand, fine to very fine, yellowish orange to reddish brown.	250.1
35								Contact of Fluvial Deposits estimated at 36'.	
							SC		
40									

WELL DIAGRAM

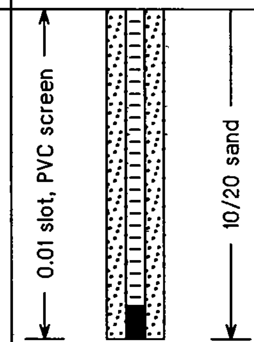


Monitoring Well 007G06UF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *284.12 feet msl*
Started at *0820 on 2-10-95*	TOC Elevation: *286.48 feet msl*
Completed at *1010 on 2-22-95*	Depth to Groundwater: *37.00 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *249.48 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *50.0 feet*
Geologist: *Ben Brantley*	Well Screen: *40 to 50 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
45			6	54	BG		SC	Silty sand, very fine to fine, traces of clay casts, grayish orange to pale yellowish orange.	
50			7	100	BG			Log information taken from the boring for the Cockfield well at SWMU#7 site 6.	234.1
55									
60									
65									
70									
75									
80									

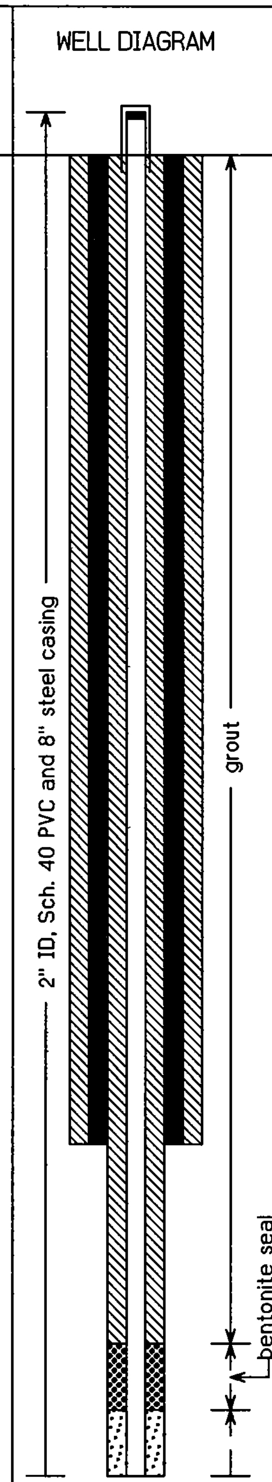
WELL DIAGRAM



Monitoring Well 007G07UF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *282.35 feet msl*
Started at *1750 on 2-10-95*	TOC Elevation: *283.98 feet msl*
Completed at *on 2-23-95*	Depth to Groundwater: *26.16 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.81 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *51.4 feet*
Geologist: *Ben Brantley and David Ladd*	Well Screen: *40.9 to 50.9 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
0							ML	Clayey silt, moderate yellowish brown, organics, mottled with yellowish gray silt.	
5			1	125	BG				
10			2	70	BG				
15			3	80	BG			Clayey silt, light olive gray to olive brown, soft, moist.	
25			4	65	BG				
28								Silty clay, light brown to moderate yellowish brown.	
34								Contact of Fluvial Deposits estimated at 34'.	
35			5	90	BG				246.9
35.4							SC	Silty sand, moderate yellowish brown to dark yellowish orange, stained reddish brown.	243.4
38.9							SP		
40									



Monitoring Well 007G07UF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *282.35 feet msl*
Started at *1750 on 2-10-95*	TOC Elevation: *283.98 feet msl*
Completed at *on 2-23-95*	Depth to Groundwater: *26.16 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.81 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *51.4 feet*
Geologist: *Ben Brantley and David Ladd*	Well Screen: *40.9 to 50.9 feet*

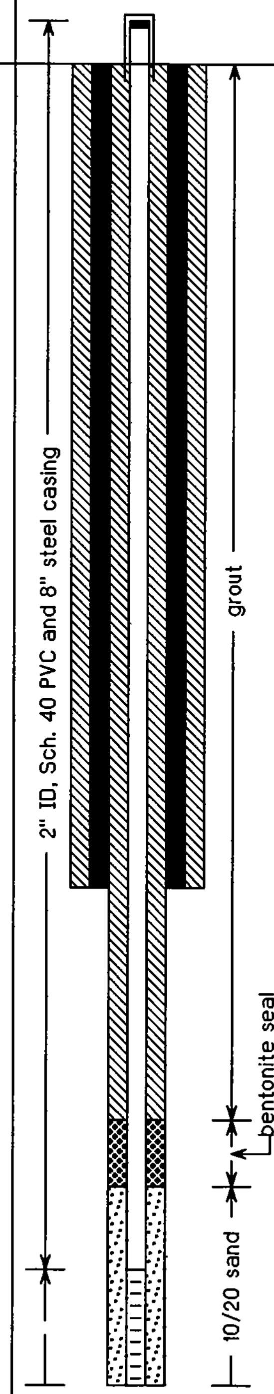
DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)	WELL DIAGRAM
								Sand, fine to medium, silty, grayish orange to dark yellowish orange, at 39' there is some gray sand.		0.01 slot, PVC screen; 10/20 sand
45			6	110	BG		SP			
50			7	90	BG			Log information taken from the boring for the Cockfield well at SWMU#7 site 7.	232.4	
55										
60										
65										
70										
75										
80										

Monitoring Well 007G08UF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *280.88 feet msl*
Started at *0900 on 2-11-95*	TOC Elevation: *282.93 feet msl*
Completed at *1210 on 2-24-95*	Depth to Groundwater: *25.69 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.25 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *47 feet*
Geologist: *David Ladd*	Well Screen: *36.5 to 46.5 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Clayey silt, yellowish brown, mottled yellowish gray.	
5			1	140	BG			Clayey silt, moderate brown, moist, soft.	
10			2	98	BG				
15			3	98	BG		ML	Clayey silt, olive gray, medium stiff to soft.	
20								Silt, light olive gray with brown mottling.	
25			4	85	BG			Silt, moderate to light brown, hard.	
30			5	80	BG				249.9
35			6	120	BG		SC	Sandy silt, moderate yellowish brown. Contact of Fluvial Deposits estimated at 31'. Sand, fine, dark yellowish orange mottled with grayish orange, silty.	244.9
40							SP	Sand, pale yellowish brown.	

WELL DIAGRAM



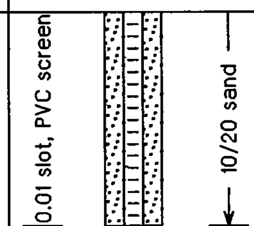
EnSafe (SM)

Monitoring Well 007G08UF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *280.88 feet msl*
Started at *0900 on 2-11-95*	TOC Elevation: *282.93 feet msl*
Completed at *1210 on 2-24-95*	Depth to Groundwater: *25.69 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.25 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *47 feet*
Geologist: *David Ladd*	Well Screen: *36.5 to 46.5 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
45	X		7	80	BG		SP		234.9
								Log information taken form the boring for the Cockfield well at SWMU#7 site 8.	
50									
55									
60									
65									
70									
75									
80									

WELL DIAGRAM



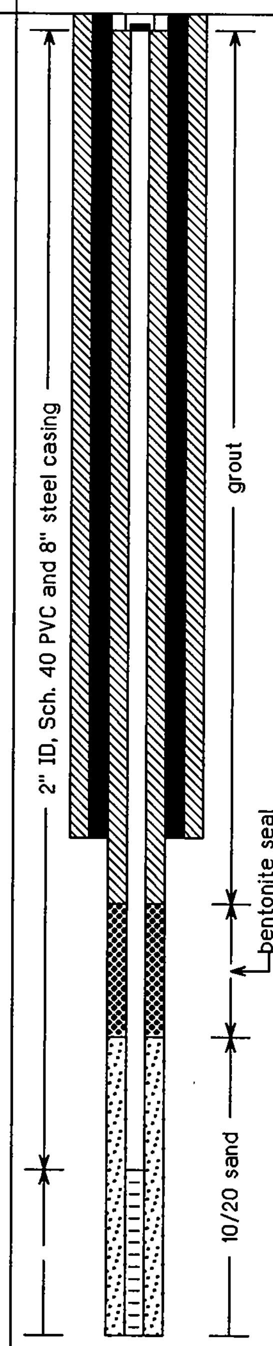
EnSafe (SM)

Monitoring Well 009G09UF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *282.90 feet msl*
Started at *1550 on 2-11-95*	TOC Elevation: *282.90 feet msl*
Completed at *on 2-16-95*	Depth to Groundwater: *25.11 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.78 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *45.5 feet*
Geologist: *Ben Brantley*	Well Screen: *35 to 45 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Clayey silt, moderate brown with yellow gray streaks, moist, soft.	
5			1	100	BG				
10			2	70	BG				
							ML		
15			3	100	BG				
								Silty clay, reddish brown, stiff and plastic.	
20								Clayey silt, light brown with clay inclusions.	
								Silty clay, moderate brown to reddish brown.	
25			4	95	BG				
								Clayey sand, fine, medium brown to reddish-brown in color.	255.9
30							SC	Contact of Fluvial Deposits estimated at 28'.	
								Sand, fine, yellow orange to light brown.	250.4
35			5	80	BG		SP		
								Sand, medium, yellowish gray, micaceous.	
40									

WELL DIAGRAM



EnSafe (SM)

Monitoring Well 009G09UF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *282.90 feet msl*
Started at *1550 on 2-11-95*	TOC Elevation: *282.90 feet msl*
Completed at *on 2-16-95*	Depth to Groundwater: *25.11 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.78 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *45.5 feet*
Geologist: *Ben Brantley*	Well Screen: *35 to 45 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)	WELL DIAGRAM
	X		6	95	BG		SP	Medium-grained sand, grayish-yellowish orange.		10/20 sand
45								Log information taken from the boring for the Cockfield well at SWMU#7 site 9.	237.4	
50										
55										
60										
65										
70										
75										
80										

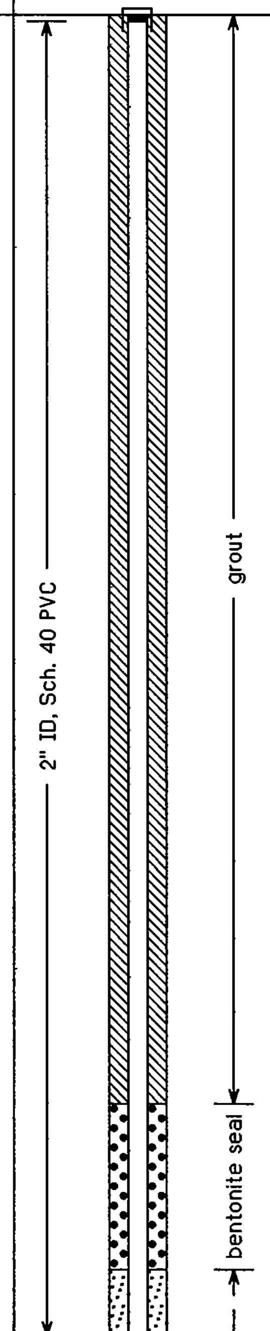
EnSafe (SM)

Monitoring Well 007G15UF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *293.79 feet msl*
Started at *1600 on 3-19-96*	TOC Elevation: *292.91 feet msl*
Completed at *1730 on 3-19-96*	Depth to Groundwater: *34.54 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.37 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *50 feet*
Geologist: *J.Kingsbury*	Well Screen: *40 to 50 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								(0'-1') Concrete.	292.8
5							CL ML	(1'-6') Silt and clay, brown to yellowish-brown.	287.8
10								(6'-35') Silt (see descriptions below). (6'-10') Silt, brown to brownish-gray, some clay, hard. (10'-26') Silt, brown to dark yellowish-brown, with some clay, with organic material from 10' to 11', moist.	
15									
20							ML		
25								(26'-29') Silt with minor clay, brown, moist.	
30								(29'-35') Silt, brown mottled with dark yellowish-orange, with organic material, some clay, hard, slightly moist.	
35							SC SM	(35'-40') Clayey and silty sand, light reddish-brown. Fluvial deposits contact estimated at 36' based on geophysical log interpretation.	258.8
40							SW SC		253.8

WELL DIAGRAM



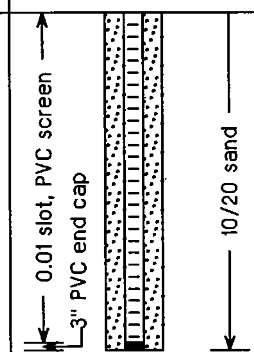
EnSafe (SM)

Monitoring Well 007G15UF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *293.79 feet msl*
Started at *1600 on 3-19-96*	TOC Elevation: *292.91 feet msl*
Completed at *1730 on 3-19-96*	Depth to Groundwater: *34.54 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.37 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *50 feet*
Geologist: *J.Kingsbury*	Well Screen: *40 to 50 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
40–46							SW/SC	(40'-46') Sand, fine to medium-grained, slightly clayey, dark yellowish-orange to light reddish-brown, with scattered gravel (up to 2" in longest dimension).	253.8
45									
46–50							SW	(46'-50') Sand, fine to medium-grained, orangish-gray to dark yellowish-orange, micaceous.	247.8
50								Terminated soil boring at 50'. Note: No samples were collected for lithologic description. These descriptions were transferred from the log of adjacent monitoring well 007G15LF.	243.8
55									
60									
65									
70									
75									
80									

WELL DIAGRAM



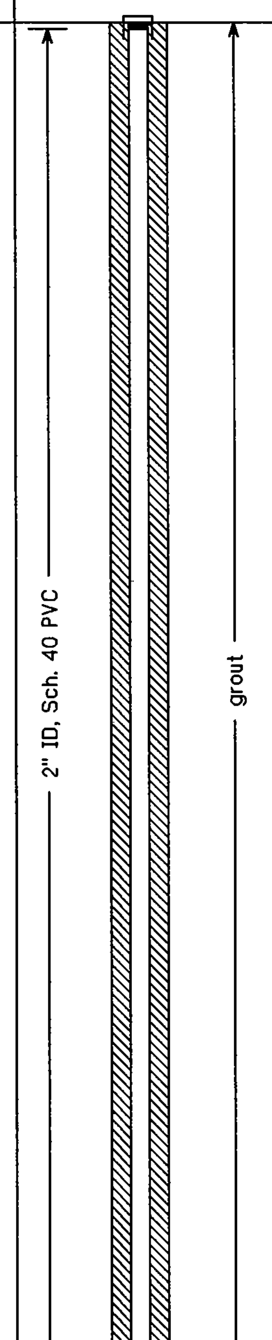
EnSafe (SM)

Monitoring Well 007G19MF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *feet msl*
Started at *1130 on 3-13-97*	TOC Elevation: *291.62 feet msl*
Completed at *1140 on 3-14-97*	Depth to Groundwater: *30.00 feet* Measured: *3/20/97*
Drilling Method: *Hollow Stem Augers*	Groundwater Elevation: *261.62 feet msl*
Drilling Company: *Tri-State Drilling*	Total Depth: *69.0 feet*
Geologist: *Charlie Ivey*	Well Screen: *57 to 67 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
					.1			Lithologic log from neighboring well 007G12LF (0-2') Concrete.	
			1		.1			(2-22') Silt, light brown to gray.	
5					.1				
					.1			Silt, light brown to yellowish-brown, with some organic material, moist.	
					.1				
10			2	70			ML		
								(14-16') With dark yellowish-orange mottling.	
15								Silt, yellowish-brown to yellowish-gray, wet.	
20			3	100					
								Clay and silt, brown, with some iron concretions.	
25								Silt and clay, yellowish-brown to light brown, with some dark yellowish-orange mottling.	
30							CL / ML		
			4	86				Contact with Fluvial Deposits (34-90') estimated at 34'.	
35									
							SC / SM	(37-43') Sand, clay, and silt, reddish-brown to dark yellowish-orange, moist.	
40									

WELL DIAGRAM

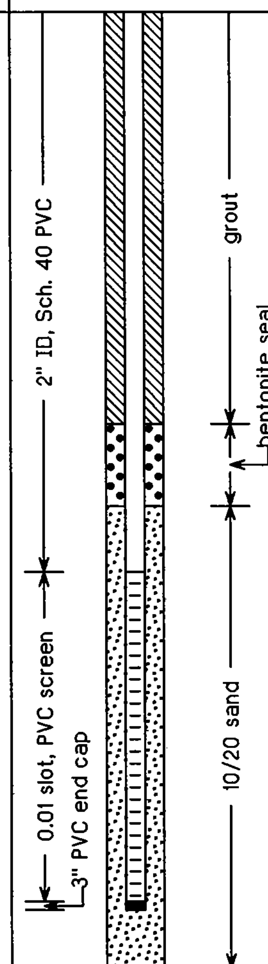


Monitoring Well 007G19MF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *feet msl*
Started at *1130 on 3-13-97*	TOC Elevation: *291.62 feet msl*
Completed at *1140 on 3-14-97*	Depth to Groundwater: *30.00 feet* Measured: *3/20/97*
Drilling Method: *Hollow Stem Augers*	Groundwater Elevation: *261.62 feet msl*
Drilling Company: *Tri-State Drilling*	Total Depth: *69.0 feet*
Geologist: *Charlie Ivey*	Well Screen: *57 to 67 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			5	100			SC/SM		
45							SW	(43-46') Sand, fine to medium-grained, reddish-brown, wet.	
50			6	92			SW/SC	(46-51') Sand, dark yellowish-brown to yellowish-gray, with very light gray clay seams up to 4" thick.	
55							SW	Sand, fine to medium-grained. Dark yellowish-orange, micaceous, wet. 3" thick clay lens.	
60							CL	(60-60.5') Clay lens, light olive gray.	
							SP	(60.5-63') Sand, medium-grained, grayish-brown, micaceous.	
65							SW	Sand, fine to coarse-grained, moderate yellowish brown to dusky yellow, with minor pea-size gravel.	
70			7	110				Soil boring terminated at 69'	
75									
80									

WELL DIAGRAM



Lower Fluvial Deposits
Boring/Well Construction Logs

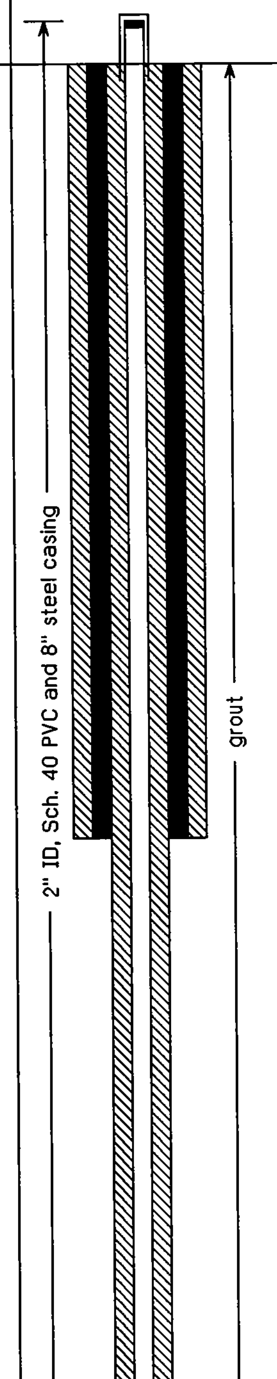
EnSafe (SM)

Monitoring Well 007G01LF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.50 feet msl*
Started at *1015 on 2-07-95*	TOC Elevation: *284.91 feet msl*
Completed at *on 2-25-95*	Depth to Groundwater: *27.03 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.87 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *70.4 feet*
Geologist: *Ben Brantley*	Well Screen: *59.8 to 69.8 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
0							ML	Clayey silt, grayish blue green, moist. Petroleum odor.	
5			1	80	BG				
								Clayey silt, moderate brown, medium stiff.	
10									
							ML	Clayey silt, moderate brown to dark yelllowish brown, mottled pale yellowish brown.	
15			2	100	BG				
								Clayey silt, light brown to reddish brown, stiff, dry.	
20								Clayey silt, moderate brown, stiff.	
25			3	100	BG		SC	Clayey sand, fine to medium, dark yellowish brown to light brown. Contact of Fluvial Deposits (26'-70') estimated at 26'.	258.5
30							SP	Medium-grained sand (30-35').	253.5
35			4	95	BG		SP		
40									

WELL DIAGRAM

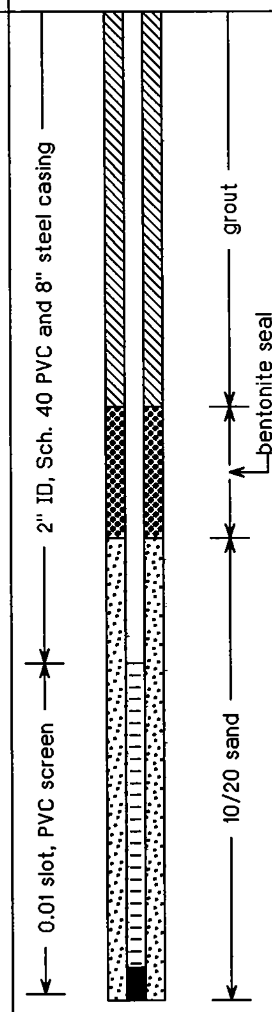


Monitoring Well 007G01LF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.50 feet msl*
Started at *1015 on 2-07-95*	TOC Elevation: *284.91 feet msl*
Completed at *on 2-25-95*	Depth to Groundwater: *27.03 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.87 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *70.4 feet*
Geologist: *Ben Brantley*	Well Screen: *59.8 to 69.8 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
45							SP		
50									231.5
								Gravelly sand, coarse, grayish orange to yellowish orange.	
55			5	90	BG				
60							GP		
65									
70			6	87	BG				213.5
								Contact of Cockfield Formation estimated at 70'. Log information taken from the boring for the Cockfield well at SWMU#7 site 1.	
75									
80									

WELL DIAGRAM

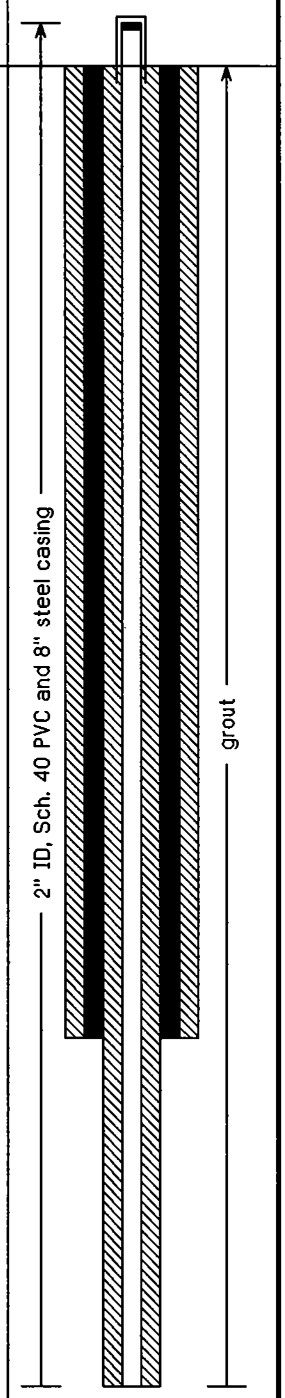


Monitoring Well 007G03LF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.82 feet msl*
Started at *1630 on 2-07-95*	TOC Elevation: *283.32 feet msl*
Completed at *1500 on 2-13-95*	Depth to Groundwater: *25.23 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.09 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *85.0 feet*
Geologist: *Ben Brantley*	Well Screen: *70.7 to 80.7 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Clayey silt, moderate brown to moderate yellowish brown, moist.	
5			1	40	BG				
10			2	120	BG				
15			3	100	BG		ML	Clayey silt, olive black, moist, soft.	
20			4	90	BG			Clayey silt, dark yellowish brown, medium stiff.	
25			5	90	BG			Clayey silt, moderate brown with yellow gray silt, organics.	
30			6	100	BG			Clayey silt with sand, moderate brown.	253.8
								Silty clayey sand, yellowish orange to yellowish brown.	
35			7	100	BG		SC	Contact of Fluvial Deposits (32'–79') estimated at 32'.	
								Silty sand, yellowish orange to reddish brown, fine to medium grained.	
40			8	120	BG				

WELL DIAGRAM



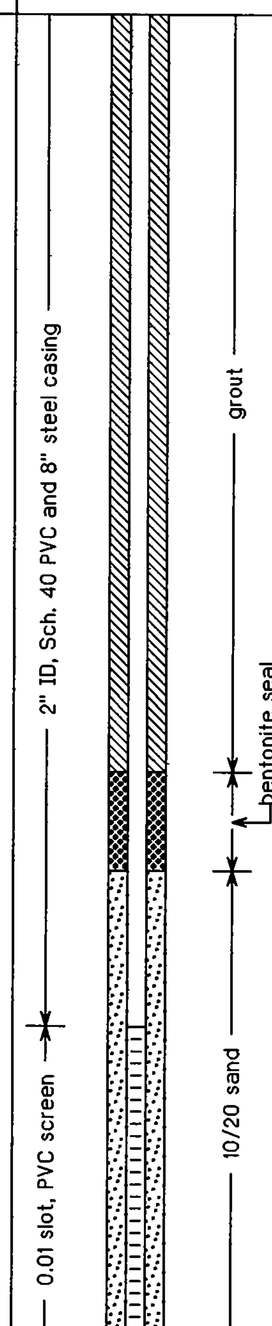
EnSafe

Monitoring Well 007G03LF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.82 feet msl*
Started at *1630 on 2-07-95*	TOC Elevation: *283.32 feet msl*
Completed at *1500 on 2-13-95*	Depth to Groundwater: *25.23 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.09 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *85.0 feet*
Geologist: *Ben Brantley*	Well Screen: *70.7 to 80.7 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
							SC	Sand, yellowish gray, fine. Sand, medium, yellowish orange to yellowish brown.	
45			9	120	BG				238.8
							GP	Sand, medium to coarse, grayish orange to yellow gray, with gravels.	
50									
55			10	75	BG				
60									
65			11	80	BG				
70									
75			12	80	BG				
									205.8
							SC	Silty sand, fine, yellowish orange to yellow gray.	
80									

WELL DIAGRAM



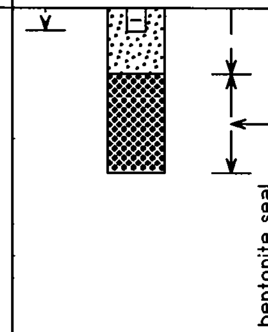
EnSafe (SM)

Monitoring Well 007G03LF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.82 feet msl*
Started at *1630 on 2-07-95*	TOC Elevation: *283.32 feet msl*
Completed at *1500 on 2-13-95*	Depth to Groundwater: *25.23 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.09 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *85.0 feet*
Geologist: *Ben Brantley*	Well Screen: *70.7 to 80.7 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
	X						SC	Clay, dusky brown to olive gray, with light gray fine sand. Contact of Cockfield Formation estimated at 80'. Log information taken from the boring for the Cockfield well at SWMU#7 site 3.	
85			13	105	BG				198.8
90									
95									
100									
105									
110									
115									
120									

WELL DIAGRAM

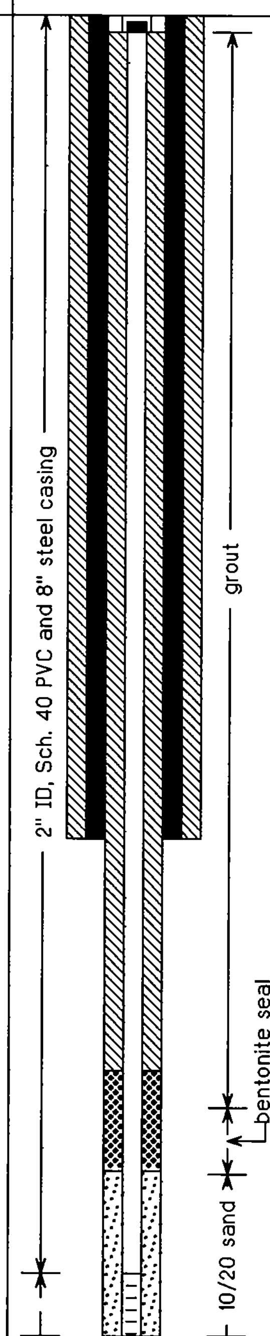


Monitoring Well 007G04UF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.71 feet msl*
Started at *0900 on 2-09-95*	TOC Elevation: *283.21 feet msl*
Completed at *0910 on 2-21-95*	Depth to Groundwater: *25.38 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.91 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *48.66 feet*
Geologist: *Jack Carmichael*	Well Screen: *38.1 to 48.1 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
0							ML	Clayey silt, moderate brown, stiff.	
4			1	62.5	BG				
10			2	50	BG				
15			3	60	BG			Clayey silt, dark yellow brown, medium stiff, moist..	
18								Clayey silt, moderate yellow with reddish brown, hard.	
20			4	80	BG				
25			5	80	BG			Clay, silty, trace sand, very fine, moderate reddish brown, stiff.	
27							SC	Sand, clayey, silty, finely micaceous, moderate reddish orange to moderate reddish brown.	256.7
30								Contact of Fluvial Deposits estimated at 30'.	
35			6	110	BG			Sand, very fine to fine, silty, clayey, laminated, small clay casts, pale orange to moderate red.	

WELL DIAGRAM

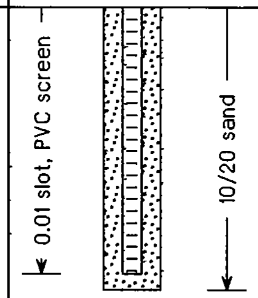


Monitoring Well 007G04UF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.71 feet msl*
Started at *0900 on 2-09-95*	TOC Elevation: *283.21 feet msl*
Completed at *0910 on 2-21-95*	Depth to Groundwater: *25.38 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.91 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *48.66 feet*
Geologist: *Jack Carmichael*	Well Screen: *38.1 to 48.1 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
45			7	105	BG		SC	Sand, very fine to fine, silty, some clay, dark yellowish orange to grayish orange, wet.	235.1
50								Log information taken from the boring for the Cockfield well at SWMU#7 Site 4.	
55									
60									
65									
70									
75									
80									

WELL DIAGRAM



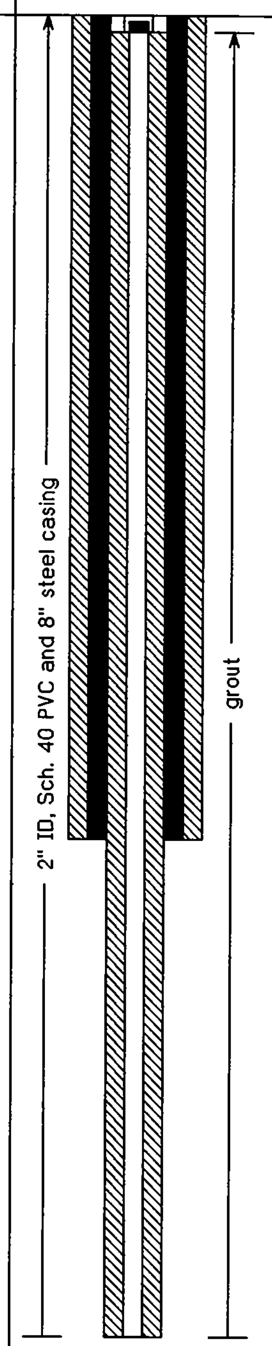
ENSAFE (SM)

Monitoring Well 007G04LF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.76 feet msl*
Started at *0900 on 2-09-95*	TOC Elevation: *283.12 feet msl*
Completed at *0910 on 2-21-95*	Depth to Groundwater: *25.28 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.92 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *70.8 feet*
Geologist: *Jack Carmichael*	Well Screen: *60.3 to 70.3 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Clayey silt, moderate brown, stiff.	
5			1	62.5	BG				
10			2	50	BG				
							ML		
15			3	60	BG			Clayey silt, dark yellow brown, medium stiff, moist..	
								Clayey silt, moderate yellow with reddish brown, hard.	
20			4	80	BG				
25			5	80	BG			Clay, silty, trace sand, very fine, moderate reddish brown, stiff.	
								Sand, clayey, silty, finely micaceous, moderate reddish orange to moderate reddish brown.	256.8
30								Contact of Fluvial Deposits (30'-71') estimated at 30'.	
							SC		
35			6	110	BG			Sand, very fine to fine, silty, clayey, laminated, small clay casts, pale orange to moderate red.	
40									

WELL DIAGRAM

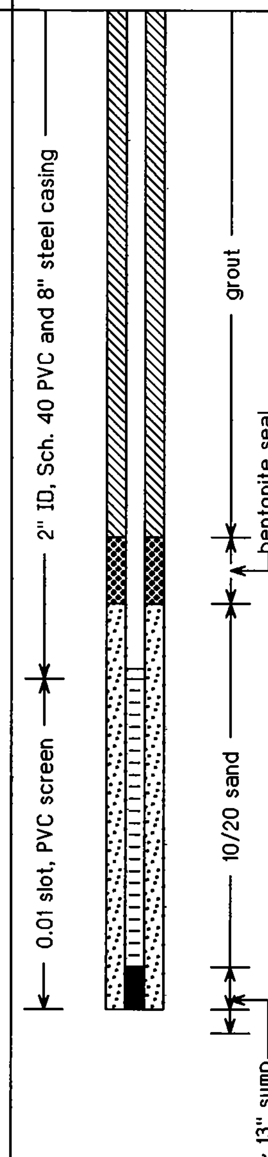


Monitoring Well 007G04LF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.76 feet msl*
Started at *0900 on 2-09-95*	TOC Elevation: *283.12 feet msl*
Completed at *0910 on 2-21-95*	Depth to Groundwater: *25.28 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.92 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *70.8 feet*
Geologist: *Jack Carmichael*	Well Screen: *60.3 to 70.3 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
							SC	Sand, very fine to fine, silty, some clay, dark yellowish orange to grayish orange, wet.	
45			7	105	BG			Sand, gravelly, clay balls, grayish orange to moderate yellowish brown.	238.8
50									
55			8	100	BG		GP	Sand with gravel, fine to coarse, grayish orange to moderate yellowish brown, wet.	
60									
65			9	100	BG			Gravel, sandy, moderate yellowish brown to dark yellowish orange.	
70			10	100	BG			Log information taken from the boring for the Cockfield well at SWMU#7 Site 4.	213.8
75									
80									

WELL DIAGRAM



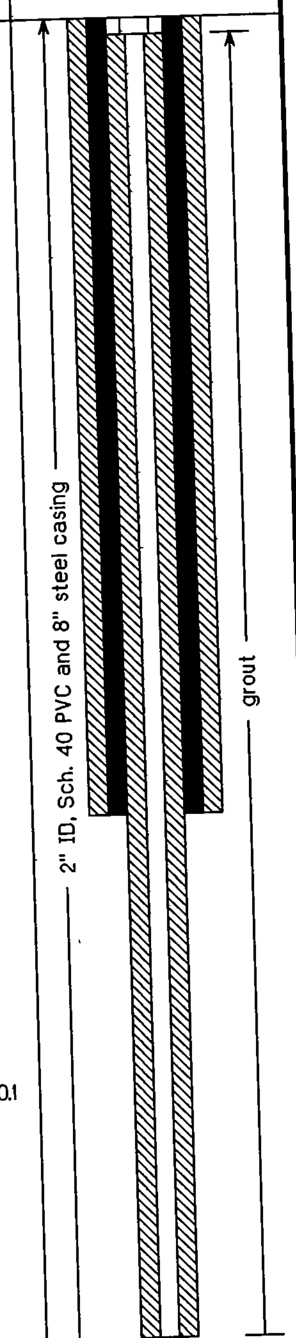
EnSafe (SM)

Monitoring Well 007G05LF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *282.65 feet msl*
Started at *on 2-09-95*	TOC Elevation: *282.28 feet msl*
Completed at *on 2-22-95*	Depth to Groundwater: *26.00 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *256.28 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *79.61 feet*
Geologist: *Jack Carmichael*	Well Screen: *69.1 to 79.1 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
0–4			1	75	BG		ML	Clayey silt, moderate brown to yellowish brown, trace of organics.	
4–10			2	60	BG		ML		
10–15			3	100	BG		ML	Clayey silt, dark yellowish brown, stiff, hard.	
15–20			4	90	BG		ML		
20–30			5	90	BG		ML		
32.5									250.1
30–35			6	90	BG		SC	Sandy clay, fine, medium light brown, soft, wet. Contact of Fluvial Deposits (33'–76') estimated at 33'. Silty sand, medium, light brown, grayish orange to yellow gray.	

WELL DIAGRAM



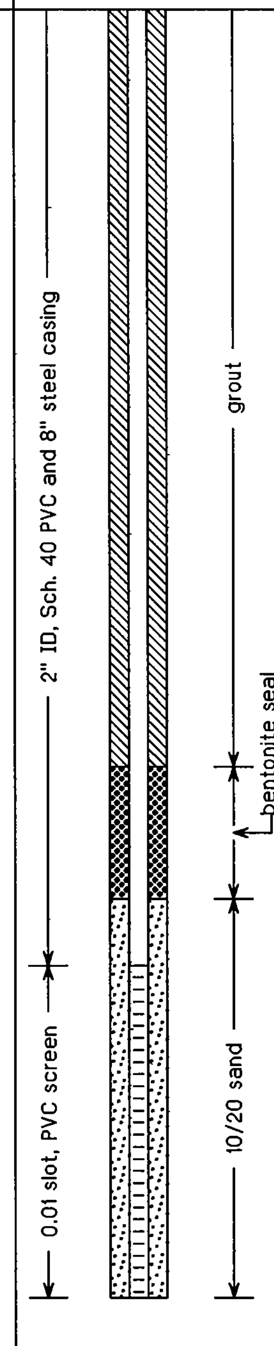
EnSafe (SM)

Monitoring Well 007G05LF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *282.65 feet msl*
Started at *on 2-09-95*	TOC Elevation: *282.28 feet msl*
Completed at *on 2-22-95*	Depth to Groundwater: *26.00 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *256.28 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *79.61 feet*
Geologist: *Jack Carmichael*	Well Screen: *69.1 to 79.1 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
							SC	Silty sand, medium, yellowish orange to light brown.	
45									237.6
								Sand, medium, micaceous, yellowish orange to light brown.	
50								Sand, medium, grayish orange, micaceous.	
55			7	60	BG		SP		
60									
65									217.6
								Gravelly sand, coarse to very coarse, dark yellowish orange.	
70							GP		
75			8	87.5	BG				
								Contact of Cockfield Formation estimated at 76'. Log information taken from the boring for the Cockfield well at SWMU#7 Site 5.	
80									203.1

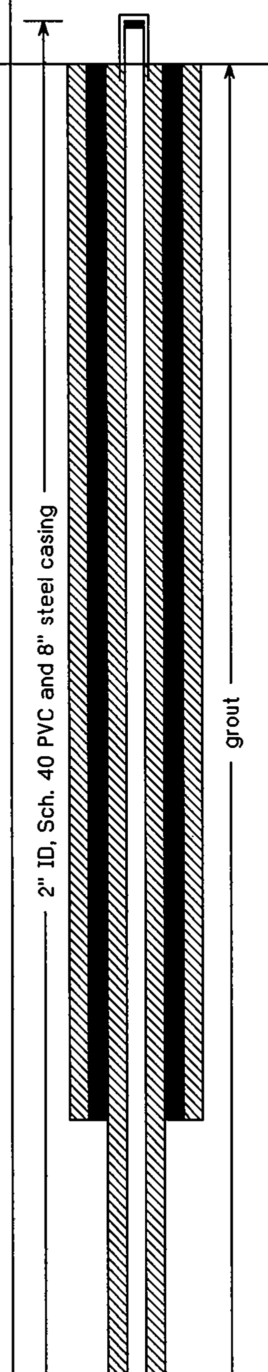
WELL DIAGRAM



Monitoring Well 007G06LF	
Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *284.39 feet msl*
Started at *0820 on 2-10-95*	TOC Elevation: *286.52 feet msl*
Completed at *1010 on 2-15-95*	Depth to Groundwater: *28.32 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.20 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *78.54 feet*
Geologist: *Ben Brantley*	Well Screen: *68 to 78 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Fill and brick.	
			1	66	BG			Clayey silt, moderate yellowish brown, mottled with yellow gray.	
5									
10			2	70	BG				
15			3	70	BG				
							ML		
20									
								Clayey silt, olive brown to olive gray, hard, stiff.	
25			4	60	BG				
								Clayey silt, light brown to yellowish brown, medium stiff.	
30									
			5	85	BG				
								Silty clayey sand, fine to very fine, yellowish orange to reddish brown.	250.4
35								Contact of Fluvial Deposits (36'-78') estimated at 36'.	
							SC		
40									

WELL DIAGRAM



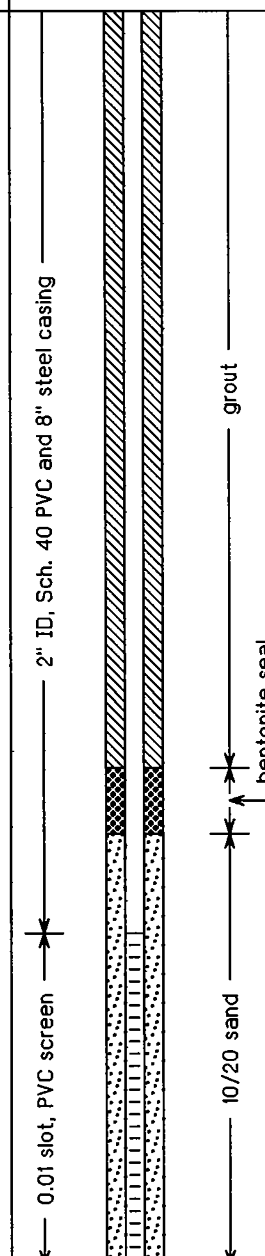
EnSafe (SM)

Monitoring Well 007G06LF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *284.39 feet msl*
Started at *0820 on 2-10-95*	TOC Elevation: *286.52 feet msl*
Completed at *1010 on 2-15-95*	Depth to Groundwater: *28.32 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.20 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *78.54 feet*
Geologist: *Ben Brantley*	Well Screen: *68 to 78 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
45			6	54	BG		SC	Silty sand, very fine to fine, traces of clay casts, grayish orange to pale yellowish orange.	
50									
55			7	100	BG		GP	Sand, fine to coarse, pale yellowish brown to moderate yellowish brown.	229.4
60									
65			8	70	BG				
70									
75			9	100	BG				
80								Log information taken from the boring for the Cockfield well at SWMU#7 site 6. Contact of Cockfield Formation estimated at 78'.	206.9

WELL DIAGRAM



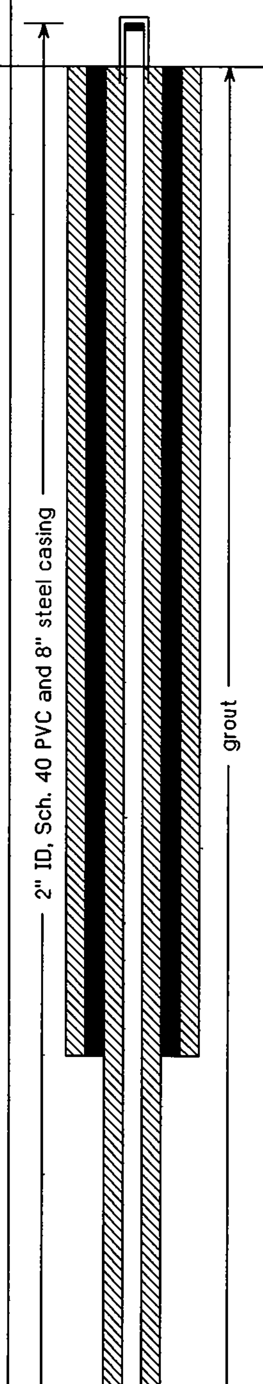
EnSafe

Monitoring Well 007G07LF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *282.35 feet msl*
Started at *1750 on 2-10-95*	TOC Elevation: *283.68 feet msl*
Completed at *on 2-23-95*	Depth to Groundwater: *25.86 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.82 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *79.6 feet*
Geologist: *Ben Brantley*	Well Screen: *69.1 to 79.1 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Clayey silt, moderate yellowish brown, organics, mottled with yellowish gray silt.	
5			1	125	BG				
10			2	70	BG				
15			3	80	BG			Clayey silt, light olive gray to olive brown, soft, moist.	
							ML		
20									
25			4	65	BG				
								Silty clay, light brown to moderate yellowish brown.	
30									
								Contact of Fluvial Deposits (34'-74') estimated at 34'.	
35			5	90	BG				246.9
							SC	Silty sand, moderate yellowish brown to dark yellowish orange, stained reddish brown.	243.4
40							SP		

WELL DIAGRAM



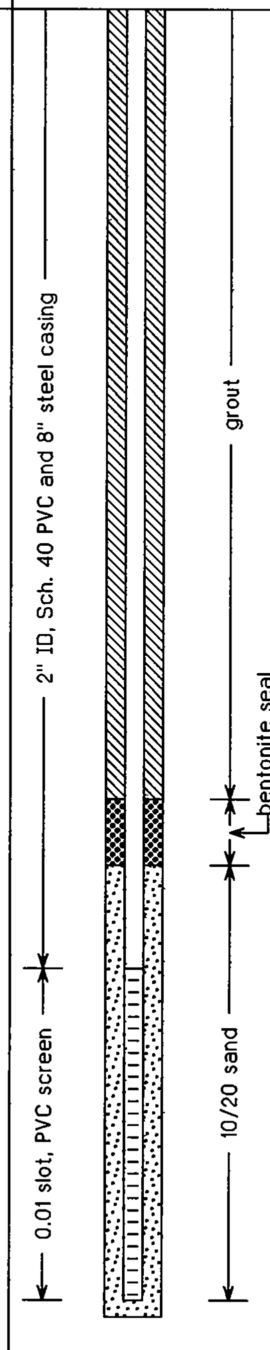
Monitoring Well 007G07LF

EnSafe (SM)

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *282.35 feet msl*
Started at *1750 on 2-10-95*	TOC Elevation: *283.68 feet msl*
Completed at *on 2-23-95*	Depth to Groundwater: *25.86 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.82 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *79.6 feet*
Geologist: *Ben Brantley*	Well Screen: *69.1 to 79.1 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Sand, fine to medium, silty, grayish orange to dark yellowish orange, at 39' there is some gray sand.	
45			6	110	BG				
50							SP		
55			7	90	BG				
60								Sand and gravel, fine to very coarse grained, grayish orange to dark yellowish orange.	222.4
65			8	110	BG				
70							GP	Sand with interdisbursed clay, fine to medium grained. Clay is pinkish gray, moist.	
75			9	95	BG			Contact of Cockfield Formation estimated at 74'.	
80			10	100	BG			Log information taken from the boring for the Cockfield well at SWMU#7 site 7.	202.7

WELL DIAGRAM

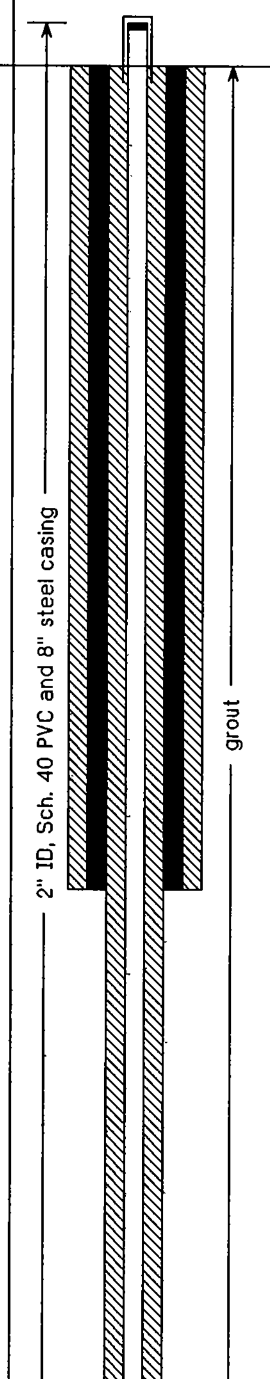


Monitoring Well 007G08LF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *280.95 feet msl*
Started at *0900 on 2-11-95*	TOC Elevation: *282.92 feet msl*
Completed at *1210 on 2-25-95*	Depth to Groundwater: *25.86 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.59 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *77.1 feet*
Geologist: *David Ladd*	Well Screen: *66.6 to 76.6 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Clayey silt, yellowish brown, mottled yellowish gray.	
5			1	140	BG			Clayey silt, moderate brown, moist, soft.	
10			2	98	BG				
15			3	98	BG		ML		
								Clayey silt, olive gray, medium stiff to soft.	
20									
								Silt, light olive gray with brown mottling.	
25			4	85	BG			Silt, moderate to light brown, hard.	
30			5	80	BG				
							SC	Sandy silt, moderate yellowish brown.	249.9
								Contact of Fluvial Deposits (31'-78') estimated at 31'.	
35			6	120	BG			Sand, fine, dark yellowish orange mottled with grayish orange, silty.	
							SP	Sand, pale yellowish brown.	244.9
40									

WELL DIAGRAM



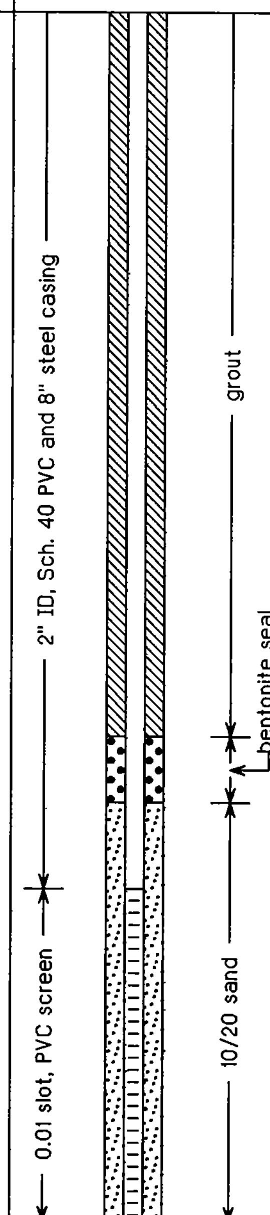
EnSafe (SM)

Monitoring Well 007G08LF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *280.95 feet msl*
Started at *0900 on 2-11-95*	TOC Elevation: *282.92 feet msl*
Completed at *1210 on 2-25-95*	Depth to Groundwater: *25.86 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.59 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *77.1 feet*
Geologist: *David Ladd*	Well Screen: *66.6 to 76.6 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
45			7	80	BG		SP	Sand, fine, grayish orange to dark yellowish orange, wet, scattered gravel.	
50									
55			8	95	BG				
60									217.9
65			9	90	BG		GP	Sand and gravel, fine to very coarse grained, grayish orange to dark yellowish orange, gravel.	
70									
75			10	90	BG				203.9
80								Log information taken form the boring for the Cockfield well at SWMU#7 site 8.	

WELL DIAGRAM

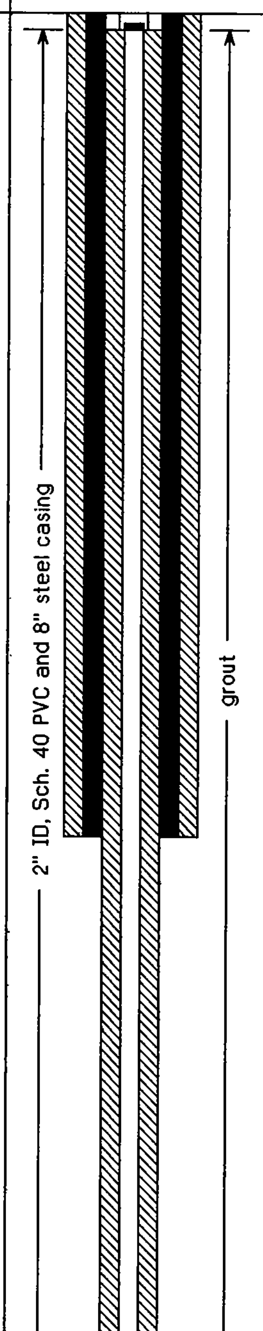


Monitoring Well 007G09LF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *282.65 feet msl*
Started at *1550 on 2-11-95*	TOC Elevation: *282.65 feet msl*
Completed at *on 2-16-95*	Depth to Groundwater: *25.47 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.42 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *80.9 feet*
Geologist: *Ben Brantley*	Well Screen: *70.4 to 80.4 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Clayey silt, moderate brown with yellow gray streaks, moist, soft.	
5			1	100	BG				
10			2	70	BG				
							ML		
15			3	100	BG				
								Silty clay, reddish brown, stiff and plastic.	
20								Clayey silt, light brown with clay inclusions.	
								Silty clay, moderate brown to reddish brown.	
25			4	95	BG				
									255.6
								Clayey sand, fine, medium brown to reddish-brown.	
30							SC	Contact of Fluvial Deposits (28'-73') estimated at 28'.	
									250.1
								Sand, fine, yellow orange to light brown.	
35			5	80	BG				
							SP		
								Sand, medium, yellowish gray, micaceous.	
40									

WELL DIAGRAM

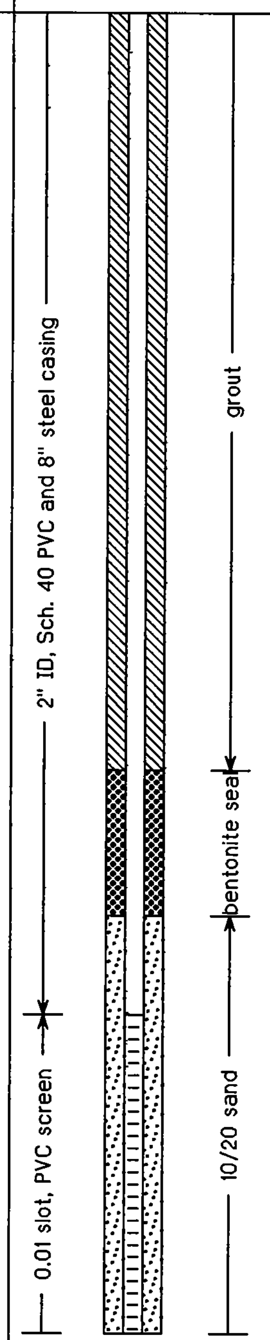


Monitoring Well 007G09LF

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *282.65 feet msl*
Started at *1550 on 2-11-95*	TOC Elevation: *282.65 feet msl*
Completed at *on 2-16-95*	Depth to Groundwater: *25.47 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.42 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *80.9 feet*
Geologist: *Ben Brantley*	Well Screen: *70.4 to 80.4 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
45			6	95	BG				
50							SP		
55									
60								Sand, Coarse to gravelly, grayish orange to yellowish orange.	222.6
65			7	90	BG		GP		
70									
73								Silty sand, very fine, yellowish orange banded with yellowish gray. Contact of Cockfield Formation estimated at 73'.	209.6
75									
			8	95	BG		SC		
80									

WELL DIAGRAM



Monitoring Well 007G09LF

Project: NSA Memphis	Location: Millington, TN. Building N-126
Project No.: 0094	Surface Elevation: 282.65 feet msl
Started at 1550 on 2-11-95	TOC Elevation: 282.65 feet msl
Completed at on 2-16-95	Depth to Groundwater: 25.47 feet Measured: 3/31/95
Drilling Method: Rotasonic	Groundwater Elevation: 257.42 feet msl
Drilling Company: North Star Drilling	Total Depth: 80.9 feet
Geologist: Ben Brantley	Well Screen: 70.4 to 80.4 feet

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)	WELL DIAGRAM
							SC	Log information taken from the boring for the Cockfield well at SWMU#7 site 9.	202.2	
85										
90										
95										
100										
105										
110										
115										
120										

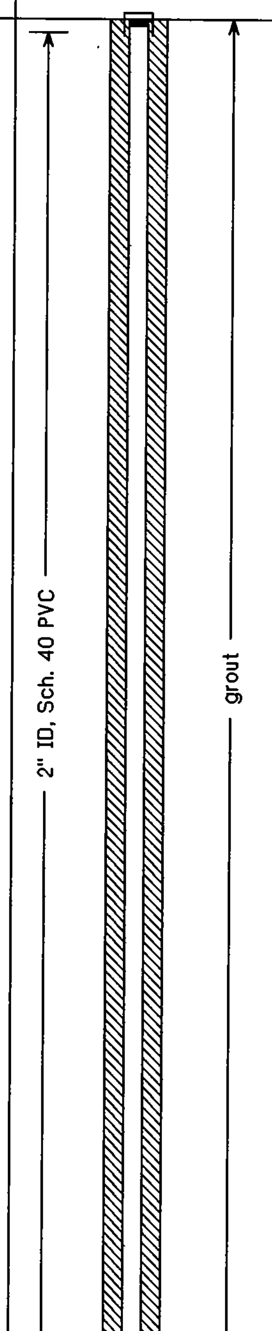
EnSafe

Monitoring Well 007G10LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU#7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *282.22 feet msl*
Started at *0745 on 3-18-96*	TOC Elevation: *282.01 feet msl*
Completed at *0930 on 3-18-96*	Depth to Groundwater: *33.47 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *248.54 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *86.0 feet*
Geologist: *J. Kingsbury*	Well Screen: *68 to 78 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
0–10			1	46	.1, .1, .1, .1, .1		ML	(0-10') Silt, brown, with some clay and some organic material.	272.2
10–12							ML / CL	(10-12') Silt and clay, olive gray, more organic material.	270.2
12–28			2	75			ML	(12-28') Silt, yellowish-grown to yellowish-gray with dark yellowish- orange mottling, minor clay and organics.	254.2
28–40							CL / ML	(28-48') Clay with some silt, brownish-gray. Silt and clay, light gray to light brown, with some dark yellowish- orange mottling, moist. Silt with clay and a trace of sand, yellowish-brown to dark yellowish- gray, with organics from 37' to 38', moist.	

WELL DIAGRAM



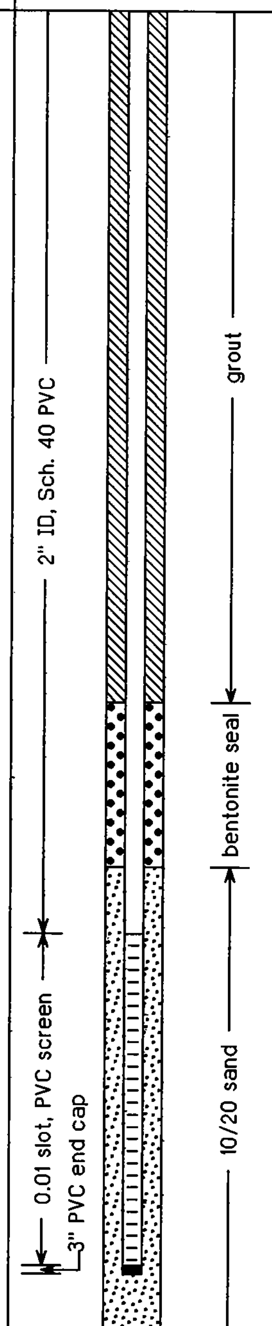
EnSafe (SM)

Monitoring Well 007G10LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU#7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *282.22 feet msl*
Started at *0745 on 3-18-96*	TOC Elevation: *282.01 feet msl*
Completed at *0930 on 3-18-96*	Depth to Groundwater: *33.47 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *248.54 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *86.0 feet*
Geologist: *J. Kingsbury*	Well Screen: *68 to 78 feet*

DEPTH IN FEET	SAMPLE NO.	% RECOVERY	PID (ppm)	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
	3	110		CL/ML	Silt with some clay and some sand. Orangish-gray with some dark yellowish-orange mottling. Contact with Fluvial Deposits (41-78') estimated at 41'.	
45	4	100				234.2
50				SP/SC	(48-52') Sand and sandy clay, dark yellowish-orange and orangish-gray.	230.2
55				SC/GW	(52-56') Sand and gravel, some clay in matrix, reddish-brown with iron staining.	226.2
60	5	111		SW/GW	(56-78') Sand and gravel, yellowish-brown to dusky yellow, with gravel (up to 2" in longest dimension).	
65					Color change to dark yellowish-orange to reddish-brown.	
70						
75	6	115				204.2
80				SP	(78-86') Cockfield Formation (see descriptions below).	

WELL DIAGRAM



EnSafe (SM)

Monitoring Well 007G10LF

Project: NSA Memphis	Location: Millington, TN. SWMU#7 – Building N-126
Project No.: 0094-08420	Surface Elevation: 282.22 feet msl
Started at 0745 on 3-18-96	TOC Elevation: 282.01 feet msl
Completed at 0930 on 3-18-96	Depth to Groundwater: 33.47 feet Measured: 4/8/96
Drilling Method: Rotasonic	Groundwater Elevation: 248.54 feet msl
Drilling Company: Alliance Environmental	Total Depth: 86.0 feet
Geologist: J. Kingsbury	Well Screen: 68 to 78 feet

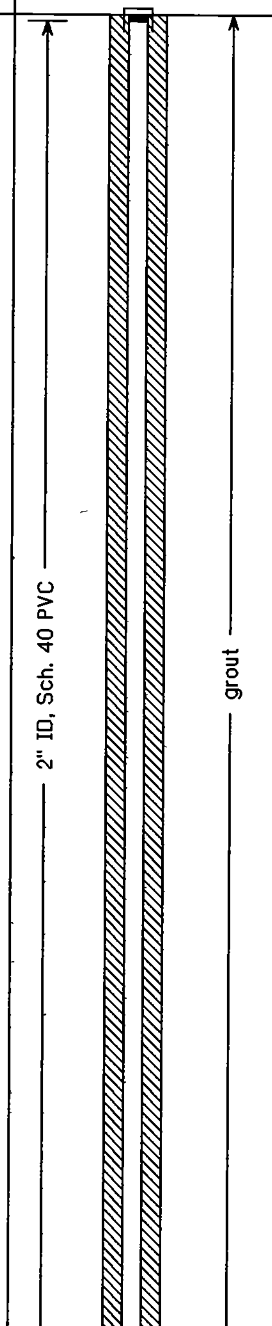
DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)	WELL DIAGRAM
							SP	(78-81') Fine sand, gray, with clay stringers.	201.2	10/20 sand
85							CL	(81-86') Clay, brown, with fine sand interbeds.	196.2	
								Soil boring terminated at 86'.		
90										
95										
100										
105										
110										
115										
120										

Monitoring Well 007G11LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *283.15 feet msl*
Started at *1200 on 3-18-96*	TOC Elevation: *282.94 feet msl*
Completed at *1500 on 3-18-96*	Depth to Groundwater: *30.76 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *252.18 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *86.0 feet*
Geologist: *J.Kingsbury*	Well Screen: *60 to 70 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
					BG			(0–36') Silt with some clay and organic material, brown with some dark yellowish-orange mottling.	
			1	83	BG				
5					BG				
					BG			Abundant organic material, yellowish-brown to light brown.	
					BG				
10			2	80					
								Moist at 12'.	
15									
							ML / CL	Silty, clayey greenish-gray to olive gray, moist to wet.	
20									
								Silty, clayey, with organic material, color change to brownish-gray.	
25			3	105					
30								Silty, clayey with organic material, yellowish-brown to yellowish- gray, only slightly moist.	
35									247.1
							ML	(36–41') Silt, slightly clayey, yellowish-brown to yellowish- gray with some dark yellowish-orange staining, with organic material and iron concretions.	
40									

WELL DIAGRAM

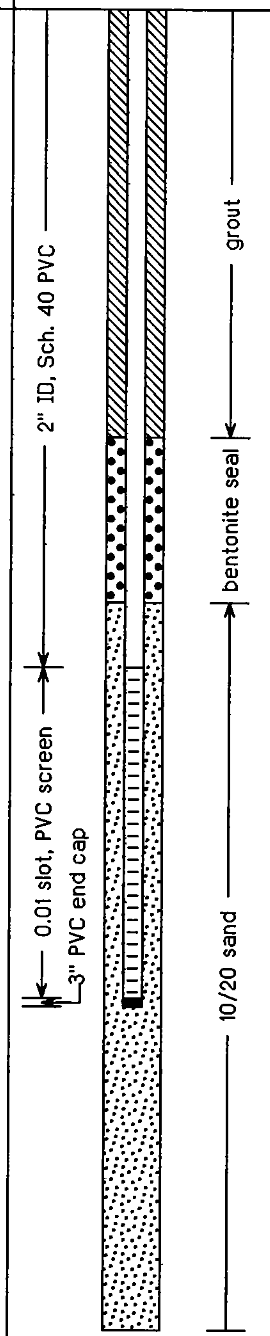


Monitoring Well 007G11LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *283.15 feet msl*
Started at *1200 on 3-18-96*	TOC Elevation: *282.94 feet msl*
Completed at *1500 on 3-18-96*	Depth to Groundwater: *30.76 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *252.18 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *86.0 feet*
Geologist: *J.Kingsbury*	Well Screen: *60 to 70 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			4	120			ML		242.1
45							CL/ML	(41-46') Clay and silt, dark yellowish-orange to orangish-gray, sandy, with a trace of small gravel. Contact with Fluvial Deposits (44-70') estimated at 44'.	237.1
50							SW/SC	(46-51') Sand (fine to medium-grained) and clay lenses, orangish-gray to yellowish-gray.	232.1
55			5	110				(51-70') Sand, coarse-grained to very coarse-grained, and gravel (up to 2" in longest dimension), yellowish-brown to dusky yellow.	
60							SW/GW		
65								Some minor clay in sand and gravel matrix from 66' to 70'.	213.1
70								Cockfield Formation: clay, dark brown, with thin interbeds of fine- grained sand, appears reworked from 70' to 72'.	
75			6	105			CL		
80									

WELL DIAGRAM



Monitoring Well 007G11LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *283.15 feet msl*
Started at *1200 on 3-18-96*	TOC Elevation: *282.94 feet msl*
Completed at *1500 on 3-18-96*	Depth to Groundwater: *30.76 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *252.18 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *86.0 feet*
Geologist: *J.Kingsbury*	Well Screen: *60 to 70 feet*

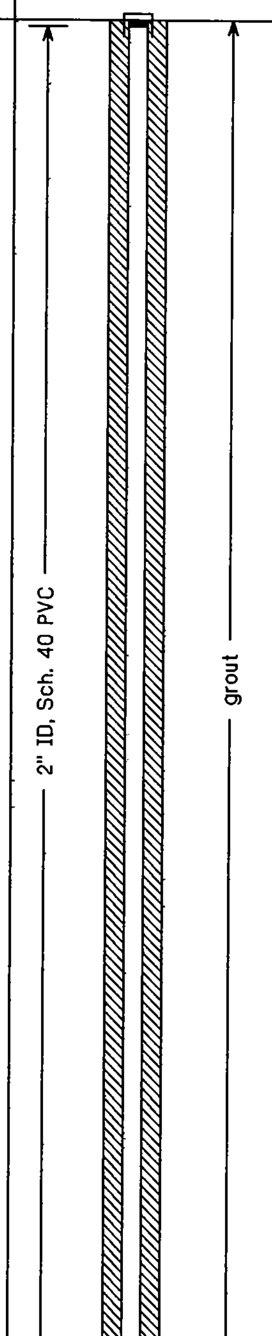
DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)	WELL DIAGRAM
85							CL			10/20 sand
								Soil boring terminated at 86'.	197.1	
90										
95										
100										
105										
110										
115										
120										

Monitoring Well 007G12LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 - Building N-126*
Project No.: *0094-08420*	Surface Elevation: *289.10 feet msl*
Started at *0800 on 3-16-96*	TOC Elevation: *288.78 feet msl*
Completed at *1240 on 3-16-96*	Depth to Groundwater: *35.68 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *253.10 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *96.0 feet*
Geologist: *J.Kingsbury*	Well Screen: *80 to 90 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
					.1			(0-2') Concrete.	
			1		.1			(2-22') Silt, light brown to gray.	287.1
5					.1				
					.1			Silt, light brown to yellowish-brown, with some organic material, moist.	
					.1				
10			2	70			ML		
15								(14-16') With dark yellowish-orange mottling.	
								Silt, yellowish-brown to yellowish-gray, wet.	
20			3	100					
								Clay and silt, brown, with some iron concretions.	267.1
25								Silt and clay, yellowish-brown to light brown, with some dark yellowish-orange mottling.	
30							CL / ML		
			4	86					
35								Contact with Fluvial Deposits (34-90') estimated at 34'.	
							SC / SM	(37-43') Sand, clay, and silt, reddish-brown to dark yellowish-orange, moist.	252.1
40									

WELL DIAGRAM



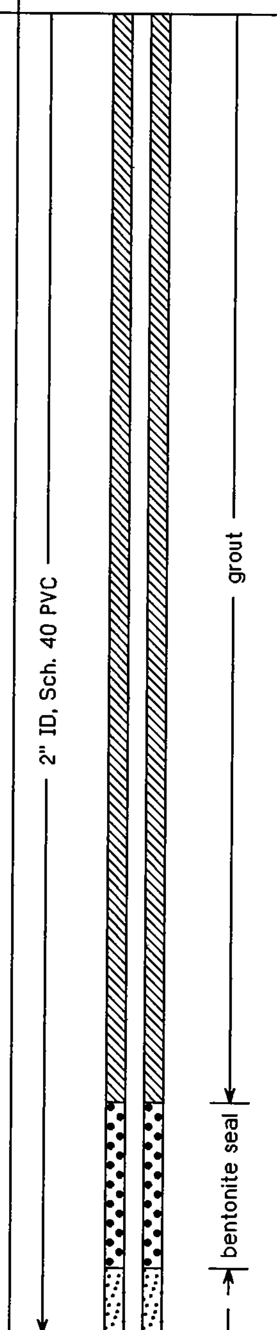
EnSafe (SM)

Monitoring Well 007G12LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *289.10 feet msl*
Started at *0800 on 3-16-96*	TOC Elevation: *288.78 feet msl*
Completed at *1240 on 3-16-96*	Depth to Groundwater: *35.68 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *253.10 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *96.0 feet*
Geologist: *J.Kingsbury*	Well Screen: *80 to 90 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			5	100			SC / SM		246.1
45							SW	(43-46') Sand, fine to medium-grained, reddish-brown, wet.	243.1
50			6	92			SW / SC	(46-51') Sand, dark yellowish-brown to yellowish-gray, with very light gray clay seams up to 4" thick.	238.1
55							SW	Sand, fine to medium-grained. Dark yellowish-orange, micaceous, wet. 3" thick clay lens.	229.1
60							CL	(60-60.5') Clay lens, light olive gray.	228.6
							SP	(60.5-63') Sand, medium-grained, grayish-brown, micaceous.	226.1
65 / 70 / 75 / 80			7	110			SW	Sand, fine to coarse-grained, moderate yellowish brown to dusky yellow, with minor pea-size gravel. With some clay lenses from 69' to 70'. Sand, fine to very coarse-grained, yellowish-gray, micaceous.	

WELL DIAGRAM



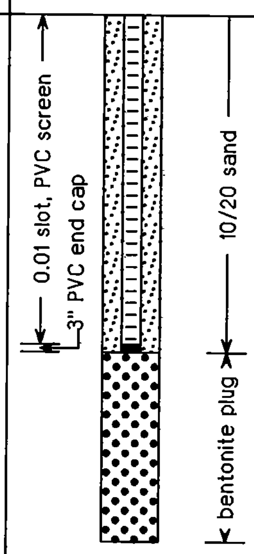
EnSafe (SM)

Monitoring Well 007G12LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *289.10 feet msl*
Started at *0800 on 3-16-96*	TOC Elevation: *288.78 feet msl*
Completed at *1240 on 3-16-96*	Depth to Groundwater: *35.68 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *253.10 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *96.0 feet*
Geologist: *J.Kingsbury*	Well Screen: *80 to 90 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			8	120			SW		208.1
							SC	(81–82.5') Sand, fine to coarse-grained, dark yellowish-orange with clay lenses between 82' and 82.5', orangish-gray.	206.6
85							SW		203.1
							SC / GC	(86–90') Sand and gravel with some clay in matrix, dark yellowish- orange.	199.1
90			9	110			CL	Cockfield Formation: Clay, dark brown, with thin interbeds of fine- grained sand.	
95									193.1
								Soil boring terminated at 96'.	
100									
105									
110									
115									
120									

WELL DIAGRAM



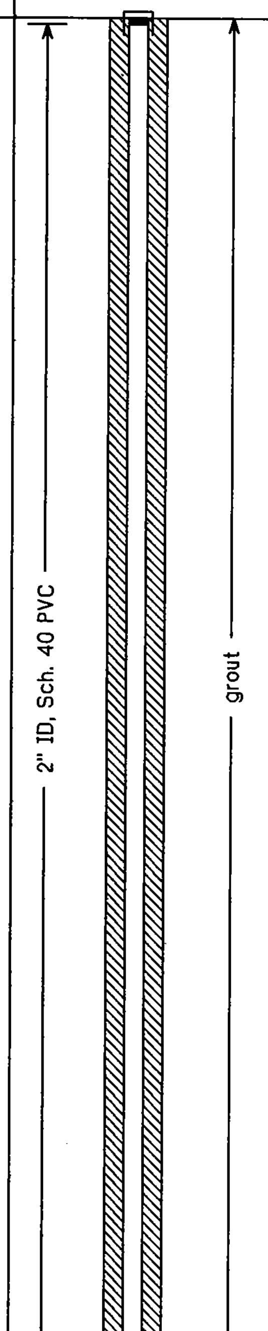
EnSafe (SM)

Monitoring Well 007G13LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *293.14 feet msl*
Started at *1430 on 3-17-96*	TOC Elevation: *292.96 feet msl*
Completed at *1600 on 3-17-96*	Depth to Groundwater: *34.91 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.05 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *86.0 feet*
Geologist: *J.Kingsbury*	Well Screen: *66 to 76 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
0–4			1	100	.3 / .3		ML	Silt, brown, with some gravel; fill 0' to 2', native material 2' to 4.	
5					.3 / .3 / .3		ML	(4-15') Silt, light brown to reddish-brown, with some clay and organic material.	
10			2	50			ML		
15							ML	(15-16') Silt, with some clay, moderate gray.	
							ML	(16-30') Silt, yellowish-brown and olive gray, with some clay, with some organic material and clay throughout, wet.	
25			3	70			ML		
30							CL/ML	(30-34') Silt and clay, greenish-gray to olive gray, moist to wet.	263.1
35							CL/ML	(34-36') Increasing clay content.	
38			4	150			ML/CL	(38-44') Clay, silty and sandy, with scattered gravel, gray to light brown.	255.1
40									

WELL DIAGRAM



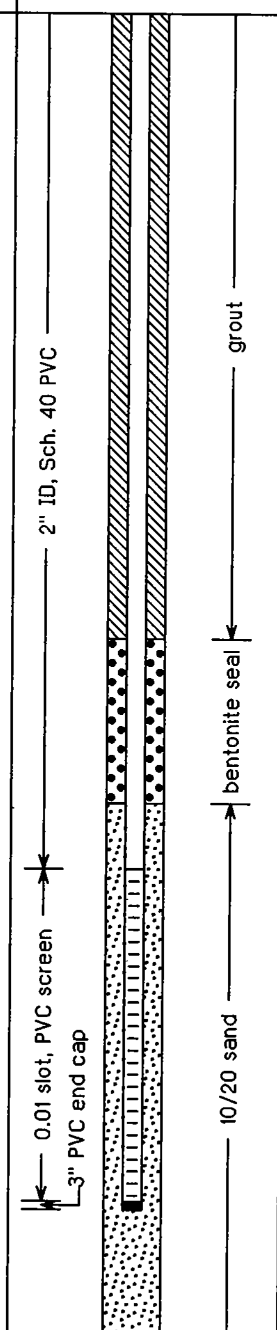
EnSafe (SM)

Monitoring Well 007G13LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *293.14 feet msl*
Started at *1430 on 3-17-96*	TOC Elevation: *292.96 feet msl*
Completed at *1600 on 3-17-96*	Depth to Groundwater: *34.91 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.05 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *86.0 feet*
Geologist: *J.Kingsbury*	Well Screen: *66 to 76 feet*

DEPTH IN FEET	SAMPLE NO.	% RECOVERY	PID (ppm)	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
				ML/CL	Color change to very light gray. Contact with Fluvial Deposits (43-78') estimated at 43'.	249.1
45	5	100		SP/SC	Sand and clayey sand, very light gray to very light brown. Sand and sandy clay, very light gray, micaceous.	
50						
55	6	117			Sand, very light gray to light brown, with a few lenses of clay and sandy clay, micaceous. (59-60') With some gravel (3" thick lense).	233.1
60				SW	(60-64') Sand, fine to medium-grained, light yellowish-brown to yellowish-gray, micaceous.	229.1
65				SC	(64-65') With some clay (interstitial).	228.1
				SW	(65-70') Sand, fine to medium-grained, light yellowish-brown to yellowish-gray, micaceous.	223.1
70				CL	(70-71') Clay, very light gray.	222.1
				SP/SC	(71-75') Sand, dark yellowish-orange to yellowish-brown, and clay, very light yellowish gray.	218.1
75	7	115		SP/GP	(75-76') Sand and gravel, sand is very coarse-grained, dark yellowish- orange.	217.1
				CL	(76-77') Clay.	216.1
				GC	(77-78') Clayey gravel.	215.1
				CL		
80						

WELL DIAGRAM



Monitoring Well 007G13LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *293.14 feet msl*
Started at *1430 on 3-17-96*	TOC Elevation: *292.96 feet msl*
Completed at *1600 on 3-17-96*	Depth to Groundwater: *34.91 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.05 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *86.0 feet*
Geologist: *J.Kingsbury*	Well Screen: *66 to 76 feet*

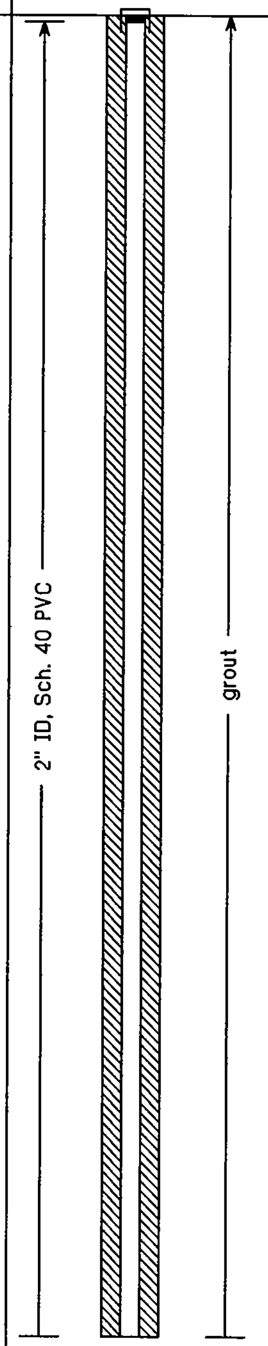
DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)	WELL DIAGRAM
							CL	(78-86') Cockfield Formation (see descriptions below). (78-79') Clay and sandy clay, grayish-orange.	211.1	10/20 sand
85							SC	(79-79.5') Dark brown, moderate brown to 80'. (82-86') Sand, fine to medium-grained, light olive gray to light yellowish-brown, with clay stringers, light gray to grayish-orange.	207.1	
								Terminated soil boring at 86'.		
90										
95										
100										
105										
110										
115										
120										

Monitoring Well 007G14LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *296.65 feet msl*
Started at *1330 on 3-16-96*	TOC Elevation: *296.43 feet msl*
Completed at *1700 on 3-16-96*	Depth to Groundwater: *37.99 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.44 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *126.0 feet*
Geologist: *J. Kingsbury*	Well Screen: *84 to 94 feet*

DEPTH IN FEET	SAMPLE NO.	% RECOVERY	PID (ppm)	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
0–2			.3		(0'-2) Concrete	294.6
2–21	1	71	.3, .3, .3, .3, .3	ML	(2'-21') Silt, brown, with some clay Moist at 10'	275.6
21–30	2	85		CL/ML	(21'-30') Brown clay with some sand and silt. Sand is fine-grained and dark yellowish-orange.	266.6
30–34				ML	(30'-34') Silt with fine sand and minor clay, very light gray with some dark yellowish-orange mottling, dry	262.6
34–36				SW/SC	(34'-94') Fluvial Deposits (see descriptions below). (34'-36') Fine to medium-grained sand, dark yellowish-orange to reddish-brown color, some clay present.	260.6
36–38	3	100		CL	(36'-38') Clay, light brown.	258.6
38–40				SW		

WELL DIAGRAM



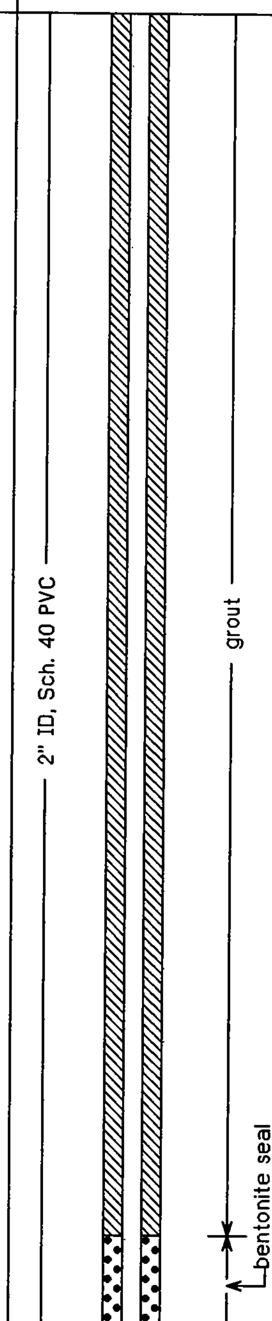
EnSafe(SM)

Monitoring Well 007G14LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *296.65 feet msl*
Started at *1330 on 3-16-96*	TOC Elevation: *296.43 feet msl*
Completed at *1700 on 3-16-96*	Depth to Groundwater: *37.99 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.44 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *126.0 feet*
Geologist: *J. Kingsbury*	Well Screen: *84 to 94 feet*

DEPTH IN FEET	SAMPLE NO.	% RECOVERY	PID (ppm)	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
38–71	4	88		SW	(38'-71') Sand (see descriptions below). (38'-43') Sand, fine to medium-grained, dark yellowish-orange. Micaceous and wet at 40' (43'-45') Sand, fine to medium-grained, brownish-gray to medium gray, micaceous. (45'-48') Clay seam. (48'-54') Sand, fine to medium-grained, yellowish-gray and micaceous, with some minor clay. (54'-63') Sand, medium to very coarse-grained, dusky yellow, and minor gravel. (63'-66') Sand, fine to medium-grained, yellowish-gray to very light gray, with minor clay. (66'-71') Sand, fine to very coarse-grained, yellowish-gray to dark yellowish-orange, with minor gravel.	225.6
71–80	5			SW/CL	(71'-84') Sand, sandy clay, and clay; alternating beds of sand and clay .5' to 1.0 feet thick; sand is fine to medium-grained, dark yellowish-orange to moderate yellowish-brown, clay is very light gray to yellowish-gray.	

WELL DIAGRAM

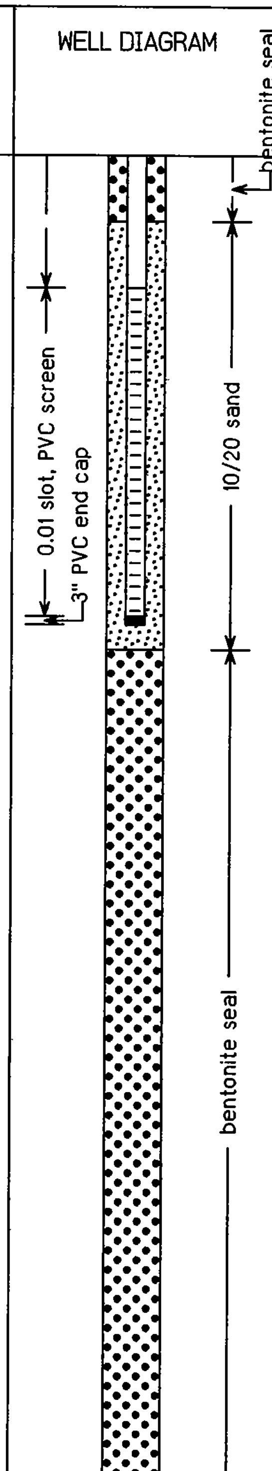


EnSafe (SM)

Monitoring Well 007G14LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *296.65 feet msl*
Started at *1330 on 3-16-96*	TOC Elevation: *296.43 feet msl*
Completed at *1700 on 3-16-96*	Depth to Groundwater: *37.99 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.44 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *126.0 feet*
Geologist: *J. Kingsbury*	Well Screen: *84 to 94 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
							SW/CL		212.6
85							SW	(84'–86') Sand, fine to coarse-grained, dusky yellow to dark yellowish-orange.	210.6
90			6	100			SW/GW	(86'–94') Sand, fine to very coarse-grained, dusky yellow to yellowish-brown and gravel (up to 1.5" in longest dimension).	202.6
95							SW	(94–126') Cockfield Formation (see descriptions below). Fine to medium-grained sand, yellowish-brown to very light gray color, with a small amount of gravel near 96'.	
100			7	95				(96'–104') Sand, fine to medium-grained, medium yellowish-gray to dark yellowish-orange.	
105								With a few thin stringers of clay at 104'	
110			8	120				(106'–116') Sand, fine to medium-grained, yellowish-brown to yellowish-gray, with some dark yellowish-orange mottling, a few clay stringers throughout, and some sparse scattered gravel (up to 1" in longest dimension).	
115									180.6
120							SC	(116'–126') Sand, fine to medium-grained, grayish-orange to dark, yellowish-orange with streaks of clay throughout	



Monitoring Well 007G14LF

Project: NSA Memphis	Location: Millington, TN. SWMU 7 – Building N-126
Project No.: 0094-08420	Surface Elevation: 296.65 feet msl
Started at 1330 on 3-16-96	TOC Elevation: 296.43 feet msl
Completed at 1700 on 3-16-96	Depth to Groundwater: 37.99 feet Measured: 4/8/96
Drilling Method: Rotasonic	Groundwater Elevation: 258.44 feet msl
Drilling Company: Alliance Environmental	Total Depth: 126.0 feet
Geologist: J. Kingsbury	Well Screen: 84 to 94 feet

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)	WELL DIAGRAM
125			9	120			SC			bentonite seal
								Soil boring terminated at 126'.	170.6	
130										
135										
140										
145										
150										
155										
160										

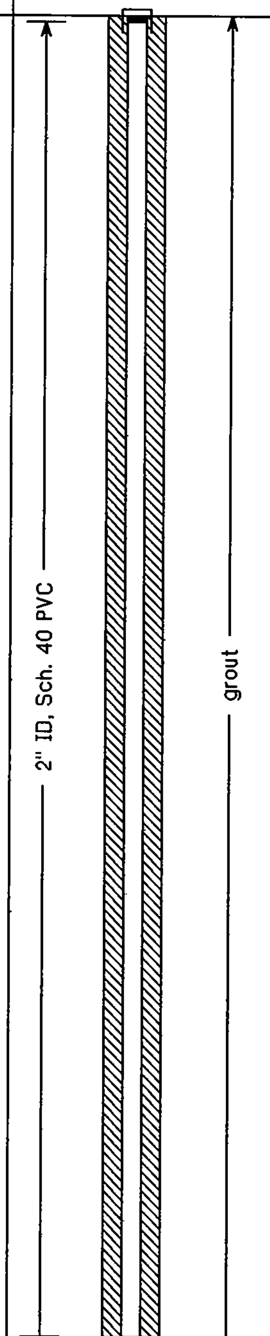
EnSafe

Monitoring Well 007G15LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *293.66 feet msl*
Started at *1315 on 3-19-96*	TOC Elevation: *293.36 feet msl*
Completed at *1530 on 3-19-96*	Depth to Groundwater: *35.65 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.71 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *106 feet*
Geologist: *J.Kingsbury*	Well Screen: *90 to 100 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
0–1					0			(0'-1') Concrete.	292.7
1–6			1	83	0, 0		CL / ML	(1'-6') Silt and clay, brown to yellowish-brown.	287.7
6–35					0, 0		ML	(6'-35') Silt, see descriptions below.	
								(6'-10') Silt, brown to brownish-gray, some clay, hard.	
								(10'-26') Silt, brown to dark yellowish-brown, with some clay, with organic material from 10' to 11', moist.	
			2	85					
								(26'-29') Silt with minor clay, brown, moist.	
								(29'-35') Silt, brown mottled with dark yellowish-orange, with organic material, some clay, hard, slightly moist.	258.7
35–40			3	100			SC / SM	(35'-40') Clayey and silty sand, light reddish-brown. Fluvial deposits contact estimated at 36' based on geophysical log interpretation.	253.7
40							SW / SC		

WELL DIAGRAM



EnSafe (SM)

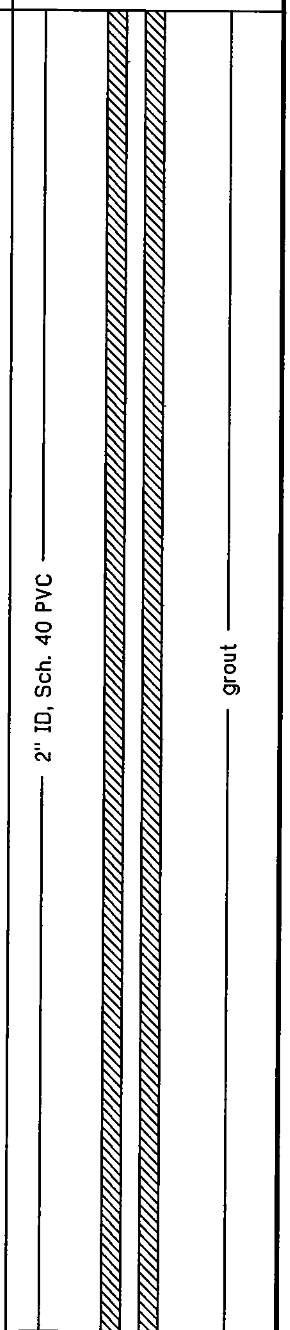
Monitoring Well 007G15LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *293.66 feet msl*
Started at *1315 on 3-19-96*	TOC Elevation: *293.36 feet msl*
Completed at *1530 on 3-19-96*	Depth to Groundwater: *35.65 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.71 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *106 feet*
Geologist: *J.Kingsbury*	Well Screen: *90 to 100 feet*

DEPTH IN FEET	SAMPLE NO.	% RECOVERY	PID (ppm)	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
40–46				SW / SC	(40'-46') Sand, fine to medium-grained, slightly clayey, dark yellowish-orange to light reddish-brown, with scattered gravel (up to 2" in longest dimension).	253.7
46–51				SW	(46'-51') Sand, fine to medium-grained, orangish-gray to dark yellowish-orange, micaceous.	247.7
51–66	4	110		SW / GW	(51'-66') Sand and minor gravel, dusky yellow to dark yellowish- orange with a few clay lenses less than 6" thick. (58'-61') Increasing gravel content.	242.7
66–80	5	105		SW	(66'-94') Sand, fine to coarse-grained, orangish-gray to dark yellowish-orange, micaceous, with a trace of gravel. Clay lens at 76'. Clay lens at 78'.	227.7

Depth scale: 45, 50, 55, 60, 65, 70, 75, 80

WELL DIAGRAM



EnSafe (SM)

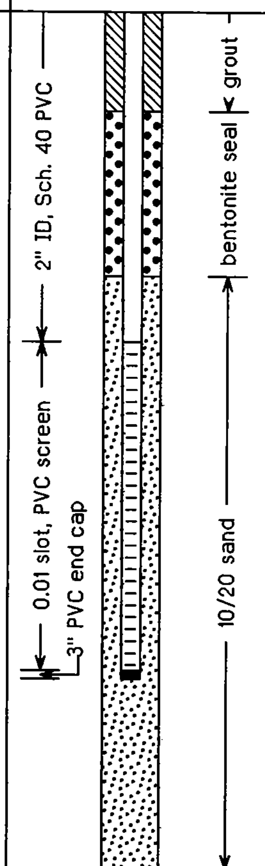
Monitoring Well 007G15LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *293.66 feet msl*
Started at *1315 on 3-19-96*	TOC Elevation: *293.36 feet msl*
Completed at *1530 on 3-19-96*	Depth to Groundwater: *35.65 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.71 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *106 feet*
Geologist: *J.Kingsbury*	Well Screen: *90 to 100 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
85–94							SW		199.7
94–100			6	95			SW/GW	(94'-100') Sand and gravel, dark yellowish-orange to dusky yellow; sand is fine to very coarse-grained, gravel is (up to 1.5" in longest dimension).	193.7
100–106							SP/SC	Cockfield Formation: Sand, fine grained, with thin lenses of clay, yellowish-gray to light gray	187.7
106								Soil boring terminated at 106'.	

Depth scale: 85, 90, 95, 100, 105, 110, 115, 120

WELL DIAGRAM



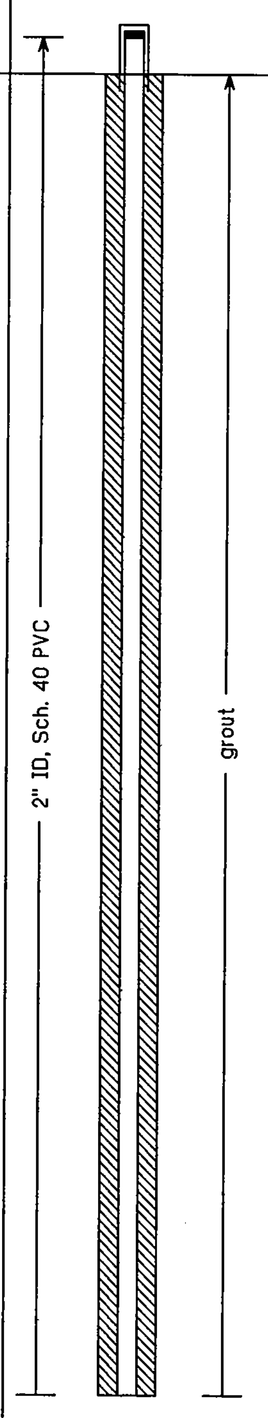
EnSafe

Monitoring Well 007G16LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *285.28 feet msl*
Started at *1318 on 3-15-96*	TOC Elevation: *287.63 feet msl*
Completed at *1500 on 3-15-96*	Depth to Groundwater: *29.29 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.34 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *86.0 feet*
Geologist: *D. Ladd*	Well Screen: *70 to 80 feet*

DEPTH IN FEET	SAMPLE NO.	% RECOVERY	PID (ppm)	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
0–2	1	100	BG	OL	(0-2') Soil, grass, and roots.	
2			BG			283.3
	2	200	BG	ML	Silt, moderate yellowish-brown mottled with light olive gray and a small amount of dark yellowish-orange, contains iron/manganese nodules.	
5			BG, BG			
			BG		Silt, dark yellowish-brown mottled with a little light olive gray.	
			BG, BG		Clayey silt, moderate yellowish-brown mottled with a little light olive gray, contains iron/manganese nodules. Moist from 14' to 15', with an increasing amount of iron/manganese nodules with depth.	
10	3	100	BG			
15					Moist.	
20	4	80			Clayey silt, dark yellowish-brown, becoming moderate yellowish-brown near 24.5', with iron-manganese nodules near 24.5, moist.	
25					Silt, dark yellowish-orange mottled with moderate yellowish-brown and light olive gray, contains iron/manganese nodules.	
26.5					Becoming sandy.	258.8
				SC	(26.5-31') Sand, fine-grained, dark yellowish-orange, locally clayey, wet. Contact with Fluvial Deposits (30-80') estimated at 30'.	
30					(31-35') Clayey sand, fine-grained, dark yellowish-brown, wet.	
	5	86				
35						250.3
				SP	Sand, fine-grained, dark yellowish-brown, wet.	
					Moderate yellowish-brown, micaceous, wet.	
					Dark yellowish-brown.	
40					Moderate yellowish-brown to grayish-orange, mottled with sparse dark yellowish-brown.	

WELL DIAGRAM



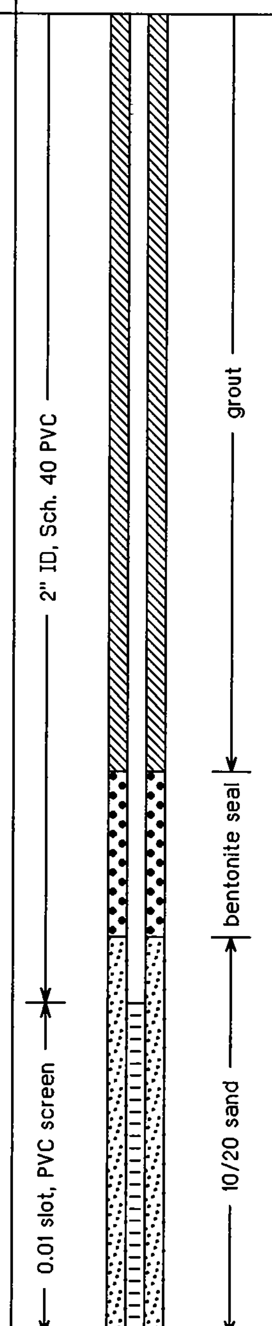
EnSafe (SM)

Monitoring Well 007G16LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *285.28 feet msl*
Started at *1318 on 3-15-96*	TOC Elevation: *287.63 feet msl*
Completed at *1500 on 3-15-96*	Depth to Groundwater: *29.29 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.34 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *86.0 feet*
Geologist: *D. Ladd*	Well Screen: *70 to 80 feet*

DEPTH IN FEET	SAMPLE NO.	% RECOVERY	PID (ppm)	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
	6	100		SP	Shelby Tube sample collected from 40' to 43' for geotechnical analysis, no sample collected for lithologic observation.	242.3
				SC	(43–44') Clayey sand, fine-grained, light brown mottled with dark yellowish-orange, wet.	241.3
45				SM	(44–45') Silty sand, fine-grained, light brown mottled with dark yellowish-orange and very light gray clayey sand, wet.	240.3
				SP	(45–48') Sand, fine-grained, grayish-orange mottled with light brown, wet. Very light gray clay seam near 48'.	237.3
50	7	100		SW	(48–53') Sand, medium to very coarse-grained, with some gravel (up to 1" in longest dimension), yellowish-gray mottled with dark yellowish-orange and grayish-orange, micaceous, wet.	232.3
55				SC	(53–57') Clayey sand, fine-grained, yellowish-gray mottled with dark yellowish-orange, with iron-manganese nodules, wet, rare gravel piece at 53.5'. Clay seam near 55', yellowish-gray mottled with pale red.	228.3
60 / 65	8	80		SW	Sand, fine to very coarse-grained, with scattered gravel (up to 0.5" in longest dimension), olive gray to light olive gray, wet. Yellowish-gray to grayish-orange with scattered gravel.	219.3
70 / 75	9	80		SP/GW	(66–77.5') Sand, very coarse-grained, and gravel; grayish-orange to dark yellowish-orange, wet. Gravel is mostly chert, increasing in size (up to 2" in longest dimension) and content near 76'.	207.8
80				SW/GW	(77.5–80') Gravel (up to 2" in longest dimension) and sand, fine to very coarse-grained, dark yellowish-orange, wet. Gravel content decreases and sand content increases near 80', the estimated contact between the Fluvial Deposits and the Cockfield Formation.	205.3
				SP		

WELL DIAGRAM

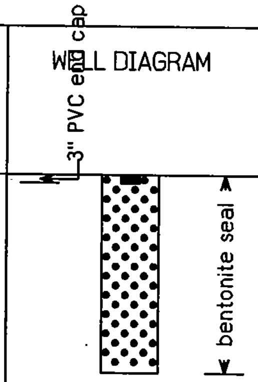


Monitoring Well 007G16LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *285.28 feet msl*
Started at *1318 on 3-15-96*	TOC Elevation: *287.63 feet msl*
Completed at *1500 on 3-15-96*	Depth to Groundwater: *29.29 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.34 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *86.0 feet*
Geologist: *D. Ladd*	Well Screen: *70 to 80 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
	X		10	120			SP	Cockfield Formation: Sand, very fine-grained, mostly lignitic, black micaceous, with a small amount of dark yellowish-brown and dark yellowish-orange clayey sand near 80'.	205.3
							SC	(81-83') Clayey sand, very fine-grained, dark yellowish-brown.	204.3
85							SP	(83-85.5') Sand, very fine-grained, light olive gray with lignitic streaks throughout, micaceous.	202.3
							SC	(85.5-86') Clayey sand, very fine-grained, dark yellowish-brown with lignitic streaks throughout, micaceous.	199.8
								Terminated soil boring at 86'.	199.3
90									
95									
100									
105									
110									
115									
120									

WELL DIAGRAM



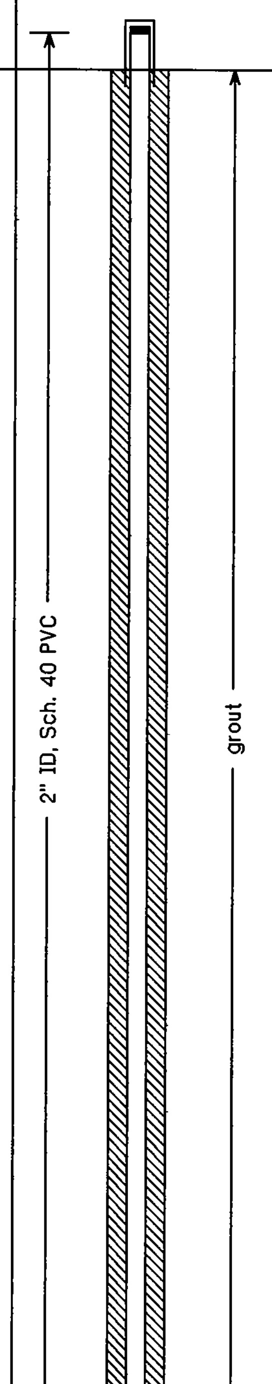
EnSafe (SM)

Monitoring Well 007G17LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *280.89 feet msl*
Started at *0750 on 3-15-96*	TOC Elevation: *283.20 feet msl*
Completed at *0956 on 3-15-96*	Depth to Groundwater: *25.19 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.01 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *86.0 feet*
Geologist: *D. Ladd*	Well Screen: *62 to 72 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
0–2			1	100	BG, BG		OL	(0'-2') Soil, grass, and roots, brick fragments.	278.9
2–34			2	120	BG, BG, BG		ML	(2'-34') Silt (see descriptions below).	
								(2'-4') Moderate yellowish-brown mottled with dark yellowish-orange and olive gray.	
5								(4'-6') Olive gray.	
					BG, BG, BG, BG			(6'-16') Olive gray to medium bluish-gray, stained light olive brown in places, with iron/manganese nodules.	
10			3	40					
15								(16'-22') Moderate yellowish-brown mottled with dark yellowish-orange and olive gray, with a few iron/manganese nodules.	
20			4	70				(22'-33') Very moist.	
25								(25'-29') Olive gray.	
								Scattered manganese nodules at 26'.	
								(29'-34') Clayey and sandy, moderate yellowish-brown mottled with olive gray, moist.	
30			5	100					246.9
34–36							SP / CL	Contact with Fluvial Deposits (34-72') estimated at 34'.	244.9
								(34'-36') Sand, very fine-grained, and silty clay, moderate yellowish-brown, moist.	
35–40							SC	Clayey sand, fine-grained, moderate reddish-brown to light brown, mottled with light olive gray and moderate yellowish-brown near 42', hard, contains rare iron concretions	

WELL DIAGRAM



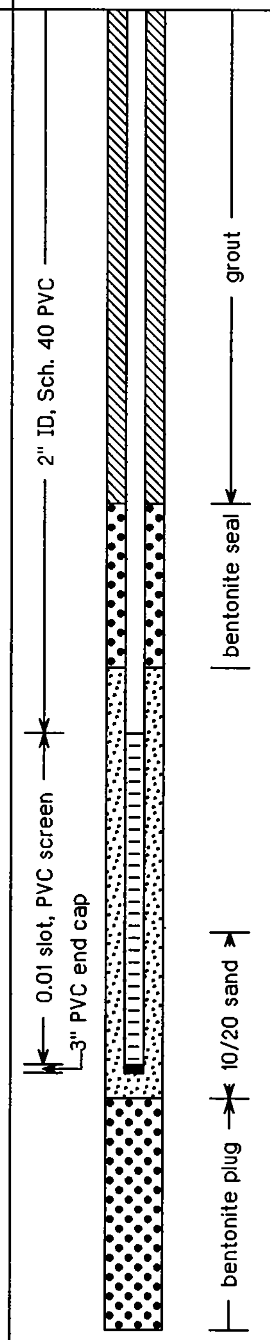
EnSafe (SM)

Monitoring Well 007G17LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *280.89 feet msl*
Started at *0750 on 3-15-96*	TOC Elevation: *283.20 feet msl*
Completed at *0956 on 3-15-96*	Depth to Groundwater: *25.19 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.01 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *86.0 feet*
Geologist: *D. Ladd*	Well Screen: *62 to 72 feet*

DEPTH IN FEET	SAMPLE NO.	% RECOVERY	PID (ppm)	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
	6	90		SC	Clayey sand, fine-grained, very light gray mottled with moderate reddish-brown, light brown, moderate yellowish-brown, and grayish-orange, hard, with rare iron concretions	
45						235.4
	7	100		SP	(45.5'-58.5') Sand (see descriptions below). Shelby Tube from 46-49'.	
50	8	158			Sand, fine-grained, dark yellowish-orange mottled with light brown from 51' to 53', becoming grayish-orange to dark yellowish-orange from 53' to 56'. Light gray clay seam at 51'. Thin gravel zone at 54'.	
55					(56'-58.5') Sand, fine-grained, grayish-orange, contains rare gravel pieces, wet.	
						222.4
60	9	100		SW	(58.5'-64') Sand, fine to coarse-grained, grayish-orange mottled with dark yellowish-orange, with gravel (up to 0.5" in longest dimension), wet.	
						216.9
65				SW / GW	(64'-72') Sand (see descriptions below). Fine to very coarse-grained, and gravel (up to 1.5" in longest dimension), grayish-orange mottled with dark yellowish orange and very light gray clayey fine sand, wet. Some of the light gray material is cemented.	
70	10	100			Fine to very coarse-grained, and gravel (up to 2" in longest dimension), dark yellowish-orange mottled with very light gray clayey material, wet.	
						208.9
75				SC	(72-86') Cockfield Formation (see descriptions below). Clayey sand, very fine-grained, dark yellowish-orange mottled with very light gray and grayish-orange, wet. Contains a small amount of gravel near 72'.	
80					(77'-78') Very wet, very light gray clay seam at 77'.	

WELL DIAGRAM



Monitoring Well 007G17LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *280.89 feet msl*
Started at *0750 on 3-15-96*	TOC Elevation: *283.20 feet msl*
Completed at *0956 on 3-15-96*	Depth to Groundwater: *25.19 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.01 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *86.0 feet*
Geologist: *D. Ladd*	Well Screen: *62 to 72 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)	WELL DIAGRAM
			11	120			SC	Clayey sand, very fine-grained, dark yellowish-brown to dusky yellowish-brown, with some light olive gray, very fine sandy seams, moist from 83' to 84'.	196.9	bentonite plug
85							CL	(84'-86') Sandy clay, dark yellowish-brown to dusky yellowish-brown mottled with light olive gray sandy seams, hard.	194.9	
								Terminated soil boring at 86.0'.		
90										
95										
100										
105										
110										
115										
120										

EnSafe (SM)

Monitoring Well 007G18LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *277.80 feet msl*
Started at *0745 on 3-19-96*	TOC Elevation: *277.58 feet msl*
Completed at *1000 on 3-19-96*	Depth to Groundwater: *23.50 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *254.08 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *116.0 feet*
Geologist: *J. Kingsbury*	Well Screen: *90 to 100 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)	WELL DIAGRAM
			1	100	BG			(0'-36') Silt, see descriptions below.		
								(1'-2') Brown, with some clay.		
			2	67	BG			(2'-6') Brown, with some clay and organic material.		
5					BG					
					BG			(6'-16') Brownish-gray to light brown with some dark yellowish-orange staining, with organic material to 16'.		
					BG					
10										
			3	80						
15										
								(16'-19') Yellowish-brown, moist.		
							ML			2" ID, Sch. 40 PVC
								(19'28') Olive gray to greenish-gray.		grout
20										
25										
			4	70						
								(28'-36') Yellowish-brown to yellowish-gray, with some clay.		
30										
35									241.8	
							CL ML	(36'-44') Clay and silt, with sandy zones and a few traces of gravel, orangish-gray to very light gray with some dark yellowish- orange staining. Fluvial deposits contact estimated at 43' based on geophysical log interpretation.		
40										

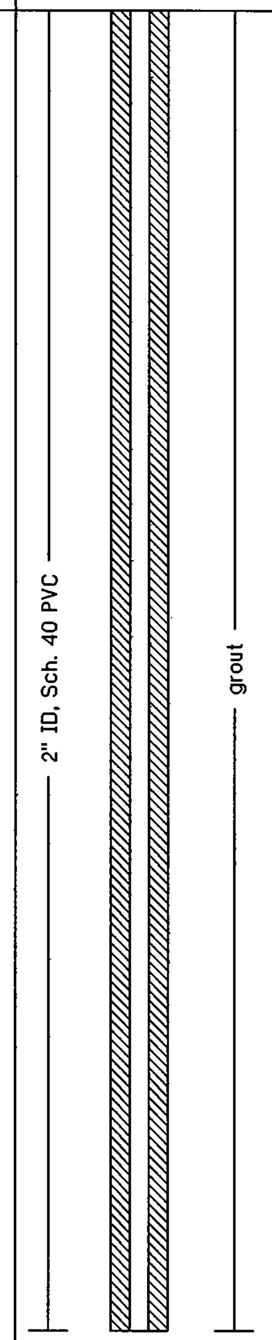
EnSafe (SM)

Monitoring Well 007G18LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *277.80 feet msl*
Started at *0745 on 3-19-96*	TOC Elevation: *277.58 feet msl*
Completed at *1000 on 3-19-96*	Depth to Groundwater: *23.50 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *254.08 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *116.0 feet*
Geologist: *J. Kingsbury*	Well Screen: *90 to 100 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			5	120			CL/ML		
45							CL/SP	(44'-46') Clay, sand, and gravel, very stiff and dense, dark yellowish-orange to orangish-gray.	233.8
50							SW	(46'-58') Sand, fine to coarse-grained, yellowish-gray to yellowish- brown, with a trace of gravel.	231.8
55			6	90					
60							SW/GW	(58'-66') Sand and gravel, reddish-brown to dark yellowish-orange. Gravel is (up to 1.5" in longest dimension), some interstitial clay present.	219.8
65							SW	(66'-72') Sand fine to very coarse-grained, dark yellowish-brown to light reddish-brown.	211.8
70									
75			7	85			SC/GW	(72'-79') Sand and gravel, brown to reddish-brown, gravel is (up to 2.5" in longest dimension), clayey from 72' to 79', iron cemented at 79'.	205.8
80							SW/GW	(79'-86') Sand and gravel, little or no clay, dark yellowish-orange to to reddish-brown.	198.8

WELL DIAGRAM



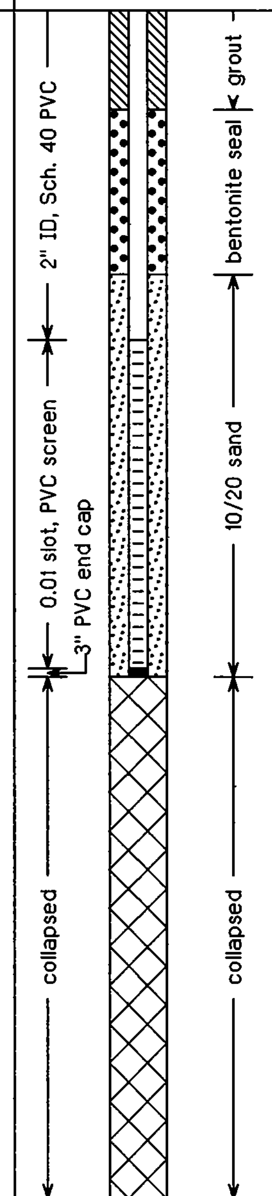
EnSafe

Monitoring Well 007G18LF

Project: *NSA Memphis*	Location: *Millington, TN. SWMU 7 – Building N-126*
Project No.: *0094-08420*	Surface Elevation: *277.80 feet msl*
Started at *0745 on 3-19-96*	TOC Elevation: *277.58 feet msl*
Completed at *1000 on 3-19-96*	Depth to Groundwater: *23.50 feet* Measured: *4/8/96*
Drilling Method: *Rotasonic*	Groundwater Elevation: *254.08 feet msl*
Drilling Company: *Alliance Environmental*	Total Depth: *116.0 feet*
Geologist: *J. Kingsbury*	Well Screen: *90 to 100 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
81–86							SW/GW		191.8
86–93			8	120			GW	(86'-93') Gravel (up to 2.5" in longest dimension), with some sand, very slightly clayey, yellowish in color.	184.8
93–100							SW/GW	(93'-100') Sand and gravel, reddish-brown to dark yellowish-orange. Cobble approximately 4" diameter near 100'.	177.8
100–116			9	110			SP	Cockfield Formation: Predominately fine-grained sand, gray, finely lignitic, with some thin stringers of clay throughout.	161.8
116–120								Soil boring terminated at 116'.	

WELL DIAGRAM



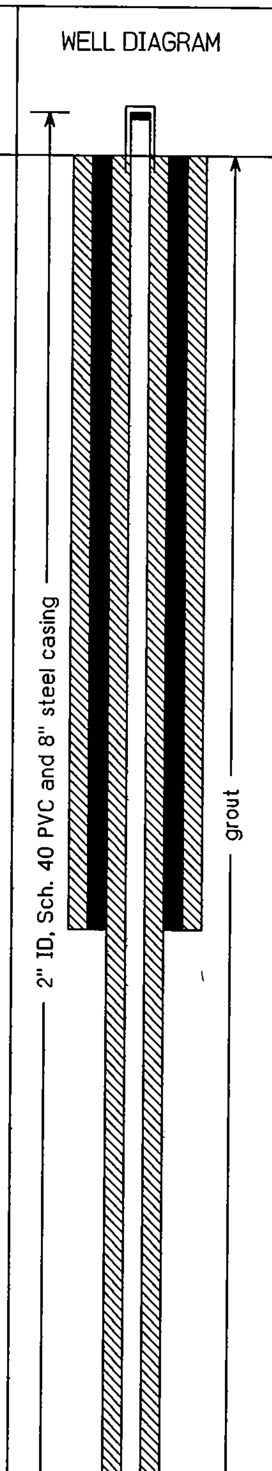
Cockfield Formation
Boring/Well Construction/Geophysical Logs

EnSafe (SM)

Monitoring Well 007G01UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *282.45 feet msl*
Started at *1015 on 2-07-95*	TOC Elevation: *284.64 feet msl*
Completed at *on 2-24-95*	Depth to Groundwater: *29.48 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *255.16 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *110.00 feet*
Geologist: *Ben Brantley*	Well Screen: *97.00 to 107.00 feet*

DEPTH IN FEET	SAMPLE NO.	% RECOVERY	PID (ppm)	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
	1		146		Clayey silt, grayish blue green, moist. Petroleum odor.	
	2		89.4			
5		80				
	3		55			
	4		9.1		Clayey silt, moderate brown, medium stiff.	
10	5		6.3			
	6		2.9	ML	Clayey silt, moderate brown to dark yelllowish brown, mottled pale yellowish brown.	
	8		24.8			
15		100				
	9		12.3		Clayey silt, light brown to reddish brown, stiff, dry.	
	10		0.3			
20	11		BG		Clayey silt, moderate brown, stiff.	
	12		BG			
25	13	100	BG			257.5
	14		BG	SC	Clayey sand, fine to medium, dark yellowish brown to light brown. Contact of Fluvial Deposits (26-70') estimated at 26'.	
	15		BG			
30						252.4
	16		BG		Medium-grained sand (30-35').	
	17		BG			
35	18	95	BG	SP		
	19		BG			
	20		BG			
40						



Monitoring Well 007G01UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *282.45 feet msl*
Started at *1015 on 2-07-95*	TOC Elevation: *284.64 feet msl*
Completed at *on 2-24-95*	Depth to Groundwater: *29.48 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *255.16 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *110.00 feet*
Geologist: *Ben Brantley*	Well Screen: *97.00 to 107.00 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			21		BG				
			22		BG				
45			23		BG				
			24		BG		SP		
			25		BG				
50			26		BG				
			27		BG			Gravelly sand, coarse, grayish orange to yellowish orange.	230.4
55			28	90	BG				
			29		0.8				
60			30						
			31		1.0		GP		
			32		0.8				
65			33		0.8				
			34		0.8			Clayey sand, fine, pale yellowish orange to moderate orange.	
70			35		BG				
			36		BG			Silty clayey sand, fine, medium gray to olive gray, contains marcasite nodules.	211.9
			37		BG			Contact of Cockfield Formation estimated at 70'.	
75			38	87	BG		SC	Sand, fine, yellowish gray to light gray, lignite at 79.5'.	
			39		BG				
80			40		BG				

WELL DIAGRAM

2" ID, Sch. 40 PVC and 8" steel casing

grout

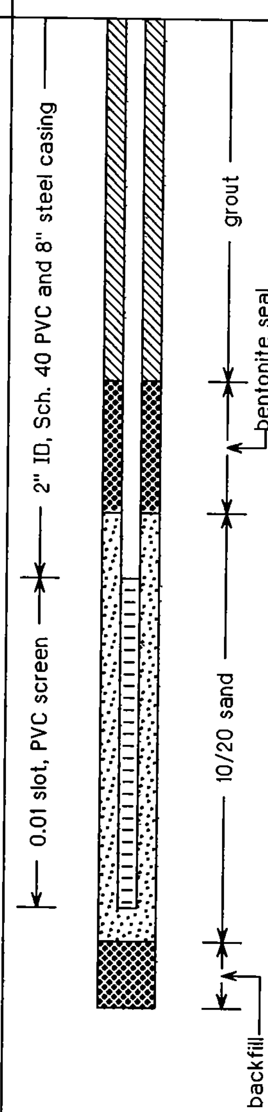
EnSafe (SM)

Monitoring Well 007G01UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *282.45 feet msl*
Started at *1015 on 2-07-95*	TOC Elevation: *284.64 feet msl*
Completed at *on 2-24-95*	Depth to Groundwater: *29.48 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *255.16 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *110.00 feet*
Geologist: *Ben Brantley*	Well Screen: *97.00 to 107.00 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			41		BG			Sand, fine, medium gray to olive gray, micaceous.	
			42		BG				
85			43		BG			Sand, fine, light olive gray to gray with dusky brown clay lenses.	
			44		BG				
			45		BG				
90			46		BG				
			47		BG		SC		
95			48	110	BG				
			49		BG				
			50		BG			Same as above but increasing amounts of clay from 99' to 105'.	
100			51		BG				
			53		BG				
105			54		BG				177.4
			55		BG		CL	Clay, waxy, dusky brown, hard, has olive gray sand lenses.	
			56		BG				
110			57	100				End of boring at 110'.	172.4
115									
120									

WELL DIAGRAM



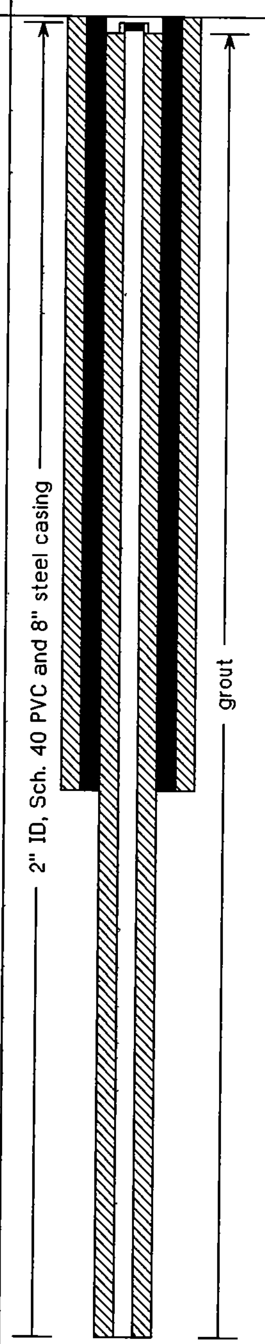
EnSafe (SM)

Monitoring Well 007G02UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.61 feet msl*
Started at *1150 on 2-07-95*	TOC Elevation: *283.18 feet msl*
Completed at *on 2-24-95*	Depth to Groundwater: *26.99 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *256.19 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *125.00 feet*
Geologist: *Ben Brantley*	Well Screen: *106.8 to 116.8 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			1		BG			Clayey silt, grayish green with dark yellow brown.	
			2		BG				
5				90					
			3		BG				
			4		41.9				
10			5		20.0				
			6		BG		ML	Clayey silt, dark yellowish brown to light olive gray.	
15			7	100	BG				
			8		BG			Clayey silt, dark yelllowish orange to light brown, medium stiff, dry.	
			9		BG				
20			10	100	BG			Clayey silt, moderate brown with organics.	
			11		BG				
			12		33.4				
25				100					258.6
			13		BG			Sandy clay, moderate reddish to light brown, medium stiff, fine. Contact of Fluvial Deposits (26-80') estimated at 26'.	
			14		BG				
30									
			15		BG		SC		
			16		BG			Silty clayey sand, medium, brown to yellowish orange, a few small gravels.	
35			17	80	BG				
			18		BG				245.6
			19		BG		SP	Sand, medium, yellowish gray to grayish orange, micaceous.	
40									

WELL DIAGRAM



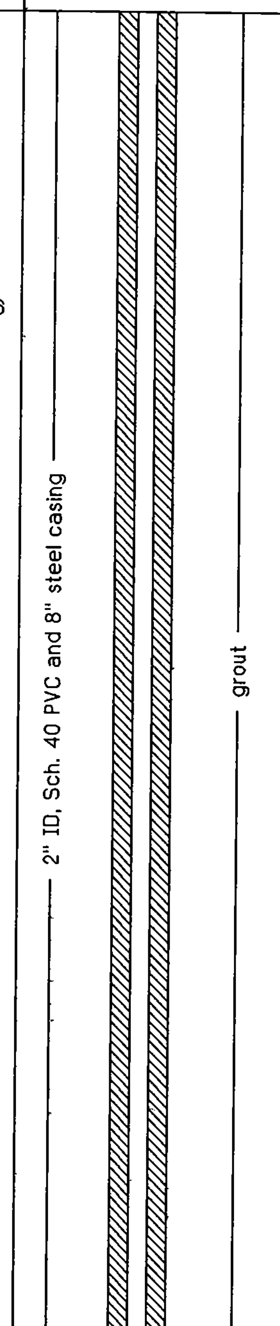
EnSafe (SM)

Monitoring Well 007G02UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.61 feet msl*
Started at *1150 on 2-07-95*	TOC Elevation: *283.18 feet msl*
Completed at *on 2-24-95*	Depth to Groundwater: *26.99 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *256.19 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *125.00 feet*
Geologist: *Ben Brantley*	Well Screen: *106.8 to 116.8 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			20		BG		SP		
			21		BG				
45			22		BG				
			23		BG				
			24		BG		GP	Sand, coarse, gravelly, grayish orange to dark yellowish orange, gravels up to 2" in diameter.	234.6
50			25		BG				
			26		BG				
55			27	87	BG				
			28		BG				
			29		BG				
60			30		BG				
			31		BG				
65			32		BG				
			33		BG				
			34		BG				
70			35		BG				
			36		BG				
75			37	90	BG		SC	Sand, fine, light gray to pale yellowish orange, with light gray clay lenses.	208.6
80									

WELL DIAGRAM

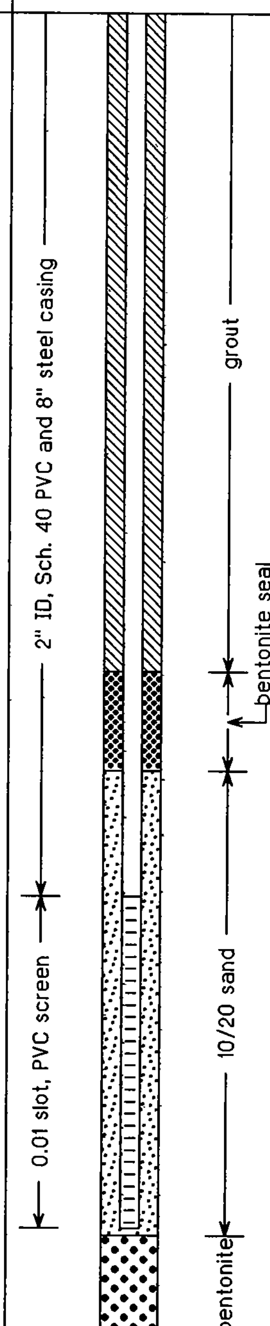


Monitoring Well 007G02UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.61 feet msl*
Started at *1150 on 2-07-95*	TOC Elevation: *283.18 feet msl*
Completed at *on 2-24-95*	Depth to Groundwater: *26.99 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *256.19 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *125.00 feet*
Geologist: *Ben Brantley*	Well Screen: *106.8 to 116.8 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
							SC	Contact of Cockfield Formation estimated at 80'.	
									201.6
85							SM	Silty sand, fine, light olive gray to grayish brown, conatains dusky brown clay lenses.	
90									
95			47	90	BG			Lignite laminations from 94'-95'.	
								Marcasite present at 98'.	
100									
105									
110									
115			9	95	BG				
									167.6
							CL	Clay, dusky brown, hard, waxy, with thin sand laminations.	
120									

WELL DIAGRAM



EnSafe (SM)

Monitoring Well 007G02UC

Project: NSA Memphis	Location: Millington, TN. Building N-126
Project No.: 0094	Surface Elevation: 283.61 feet msl
Started at 1150 on 2-07-95	TOC Elevation: 283.18 feet msl
Completed at on 2-24-95	Depth to Groundwater: 26.99 feet Measured: 3/31/95
Drilling Method: Rotasonic	Groundwater Elevation: 256.19 feet msl
Drilling Company: North Star Drilling	Total Depth: 125.00 feet
Geologist: Ben Brantley	Well Screen: 106.8 to 116.8 feet

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)	WELL DIAGRAM
	X						CL			bentonite
125			10	90	BG			End of boring at 124.57'.	158.6	
130										
135										
140										
145										
150										
155										
160										

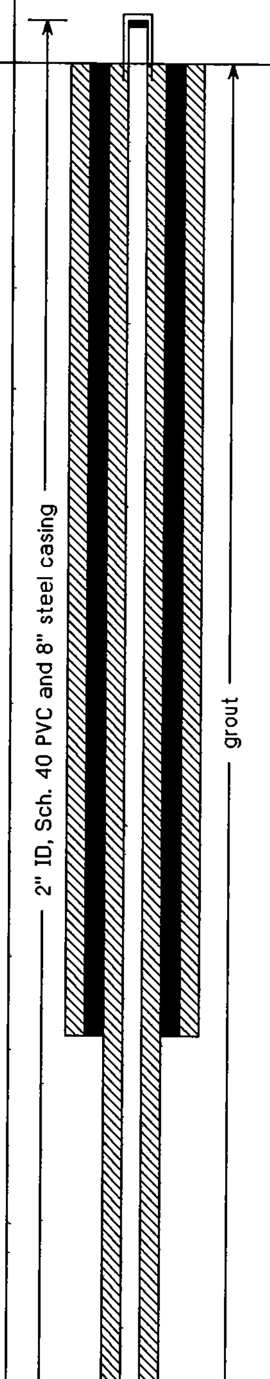
EnSafe (SM)

Monitoring Well 007G03UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.79 feet msl*
Started at *1630 on 2-07-95*	TOC Elevation: *283.47 feet msl*
Completed at *1500 on 2-14-95*	Depth to Groundwater: *26.48 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *256.99 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *115 feet*
Geologist: *Ben Brantley*	Well Screen: *100.5 to 110.5 feet*

DEPTH IN FEET	SAMPLE NO.	% RECOVERY	PID (ppm)	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
					Clayey silt, moderate brown to moderate yellowish brown, moist.	
	1		BG			
	2		BG			
5		40				
	3		BG			
	4		BG			
10	5	120	BG			
	6		BG			
	7		BG			
15		100		ML	Clayey silt, olive black, moist, soft.	
	9		BG			
	10		BG			
20	11	90	BG		Clayey silt, dark yellowish brown, medium stiff.	
	12		BG			
	13		BG			
25		90			Clayey silt, moderate brown with yellow gray silt, organics.	
	14		BG			
	15		BG			
30	16	100	BG			253.8
					Clayey silt with sand, moderate brown.	
	17		BG		Contact of Fluvial Deposits (32'-80') estimated at 32'.	
	18		BG		Silty clayey sand, yellowish orange to yellowish brown.	
35		100		SC		
	19		BG		Silty sand, yellowish orange to reddish brown, fine to medium grained.	
	20		BG			
40	21	120	BG			

WELL DIAGRAM



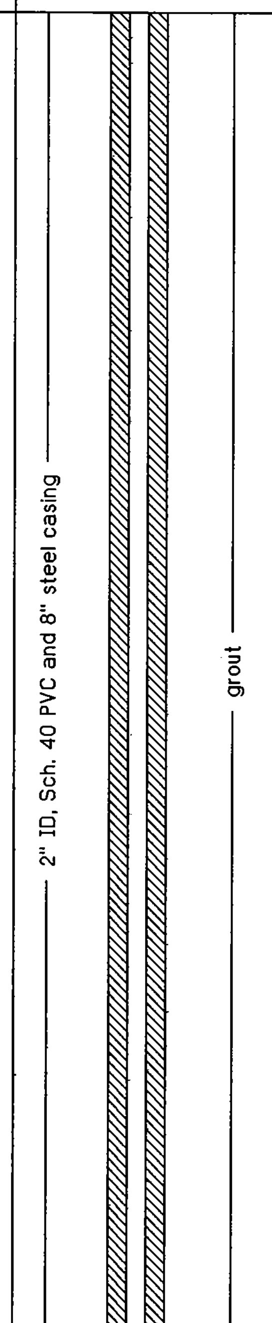
EnSafe (SM)

Monitoring Well 007G03UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.79 feet msl*
Started at *1630 on 2-07-95*	TOC Elevation: *283.47 feet msl*
Completed at *1500 on 2-14-95*	Depth to Groundwater: *26.48 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *256.99 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *115 feet*
Geologist: *Ben Brantley*	Well Screen: *100.5 to 110.5 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			22		0.2		SC	Sand, yellowish gray, fine.	
			23		0.2		SC	Sand, medium, yellowish orange to yellowish brown.	
45			24	120	BG		GP	Sand, medium to coarse, grayish orange to yellow gray, with gravels.	238.8
			25		0.2		GP		
			26		0.2		GP		
50			27		0.2		GP		
			28		BG		GP		
55			29	75	BG		GP		
			30		BG		GP		
			31		BG		GP		
60			32		BG		GP		
			33		BG		GP		
65			34	80	BG		GP		
			35		BG		GP		
			36		BG		GP		
70			37		BG		GP		
			38		0.2		GP		
75			39	80	0.2		GP		
			40		BG		GP		
			41		BG		SC	Silty sand, fine, yellowish orange to yellow gray.	205.8
80									

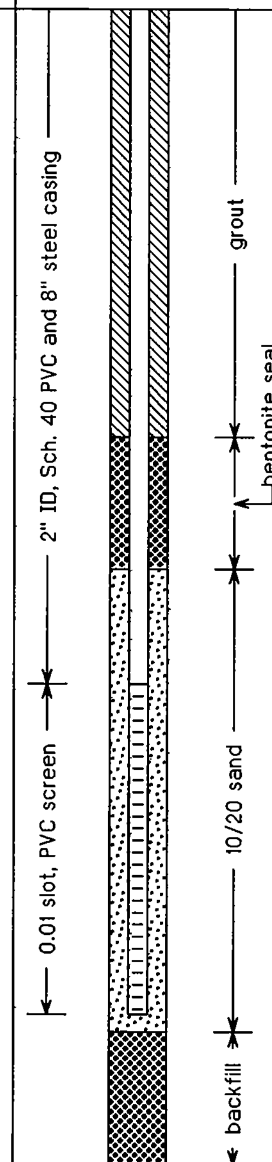
WELL DIAGRAM



ENSAFE	Monitoring Well 007G03UC
Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.79 feet msl*
Started at *1630 on 2-07-95*	TOC Elevation: *283.47 feet msl*
Completed at *1500 on 2-14-95*	Depth to Groundwater: *26.48 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *256.99 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *115 feet*
Geologist: *Ben Brantley*	Well Screen: *100.5 to 110.5 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			42		BG			Clay, dusky brown to olive gray, with light gray sand.	
			43		BG			Contact of Cockfield Formation estimated at 80'.	
85			44	105	BG				
			45		BG				
			46		BG				
90			47		BG			Clay and fine sand, dusky brown to olive color.	
			48		BG		SC	Lignitic from 91'-93'.	
95			49	105	BG				
			50		BG				
			51		BG				
100			52		BG				
			53		BG				
105			54	100	BG				
			55		BG				176.8
			56		BG			Clay, dusky brown, waxy, contains less sand.	
110			57		BG		CL		
			58		BG				
115			59	110	BG				168.8
								End of boring at 115'.	
120									

WELL DIAGRAM

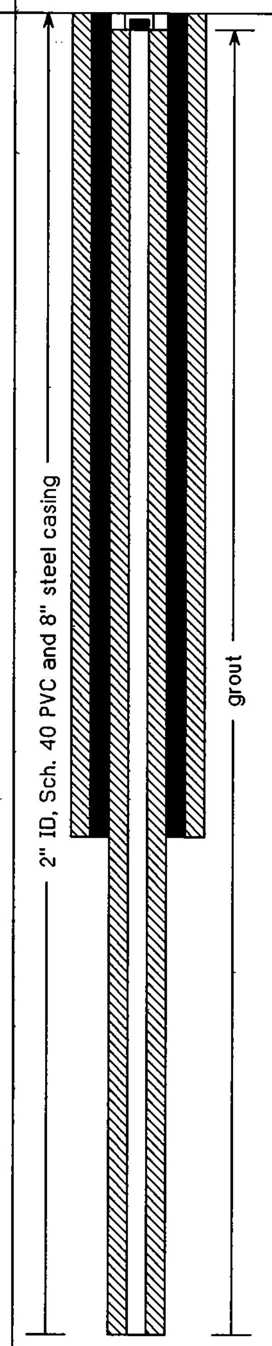


Monitoring Well 007G04UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.73 feet msl*
Started at *0900 on 2-09-95*	TOC Elevation: *283.39 feet msl*
Completed at *0910 on 2-16-95*	Depth to Groundwater: *29.67 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *253.92 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *145 feet*
Geologist: *Jack Carmichael*	Well Screen: *124.9 to 134.9 feet*

DEPTH IN FEET	SAMPLE NO.	% RECOVERY	PID (ppm)	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
					Clayey silt, moderate brown, stiff.	
	1		BG			
	2		BG			
5	3	62.5	BG			
	4		BG			
	5		BG			
10	6	50	BG			
	7		BG			
	8		BG	ML		
15		60			Clayey silt, dark yellow brown, medium stiff, moist..	
	9		BG			
	10		BG		Clayey silt, moderate yellow with reddish brown, hard.	
20	11	80	BG			
	12		BG			
25	13	80	BG		Clay, silty, trace sand, very fine, moderate reddish brown, stiff.	
	14		BG		Sand, clayey, silty, finely micaceous, moderate reddish orange to moderate reddish brown.	256.7
	15		BG			
30					Contact of Fluvial Deposits (30'-71') estimated at 30'.	
	16		BG			
	17		BG	SC		
35	18	110	BG		Sand, very fine to fine, silty, clayey, laminated, small clay casts, pale orange to moderate red.	
	19		BG			
	20		BG			
40						

WELL DIAGRAM



Monitoring Well 007G04UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.73 feet msl*
Started at *0900 on 2-09-95*	TOC Elevation: *283.39 feet msl*
Completed at *0910 on 2-16-95*	Depth to Groundwater: *29.67 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *253.92 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *145 feet*
Geologist: *Jack Carmichael*	Well Screen: *124.9 to 134.9 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)	WELL DIAGRAM
			21		BG		SC	Sand, very fine to fine, silty, some clay, dark yellowish orange to grayish orange, wet.		
			22		BG					
45			23	105	BG		GP	Sand, gravelly, clay balls, grayish orange to moderate yellowish brown.	238.7	
			24		BG					
			25		BG					
50			26		BG					
			27		BG					
55			28	100	BG			Sand with gravel, fine to coarse, grayish orange to moderate yellowish brown, wet.		2" ID, Sch. 40 PVC and 8" steel casing; grout
			29		BG					
			30		BG					
60			31		BG					
			32		BG					
65			33	100	BG			Gravel, sandy, moderate yellowish brown to dark yellowish orange.		
			34		BG					
			35		BG					
70			36		BG		SC	Sand, very fine to fine, silty, clayey, laminated, light brownish gray to grayish brown, stiff, micaceous, moist.	213.7	
			37		BG			Contact of Cockfield Formation estimated at 69.5'.		
75			38	100	BG			Sand, very fine to fine with clay streaks, pale orange to yellowish gray stained dark yellowish orange.		
			39		BG					
			40		BG					
80										

Monitoring Well 007G04UC

EnSafe (SM)

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.73 feet msl*
Started at *0900 on 2-09-95*	TOC Elevation: *283.39 feet msl*
Completed at *0910 on 2-16-95*	Depth to Groundwater: *29.67 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *253.92 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *145 feet*
Geologist: *Jack Carmichael*	Well Screen: *124.9 to 134.9 feet*

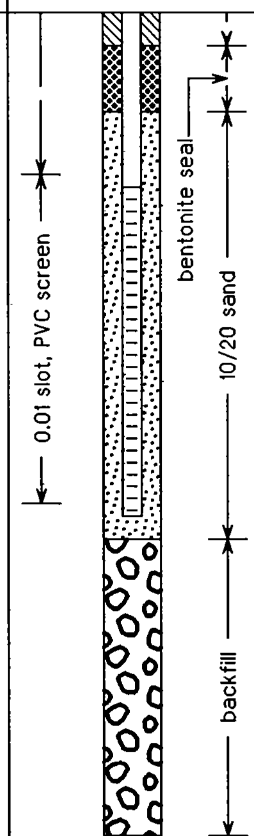
DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)	WELL DIAGRAM
			41		BG					
			42		BG			Sand, very fine to fine, with clay streaks, yellowish gray to very pale orange, stained dark yellowish orange, very wet.		
85			43	100	BG			Sand, very fine to fine, clayey, laminated, pale brown to moderate brown, wet.		
			44		BG			Sand, very fine to fine, laminated, medium gray to grayish brown, with occassional lignite chips.		
			45		BG					
90			46		BG					
			47		BG					
95			48	100	BG					
			49		BG					2" ID, Sch. 40 PVC and 8" steel casing
			50		BG					grout
100			51		BG		SC			
			52		BG					
105			53	109	BG					
			54		BG					
			55		BG					
110			56		BG					
			57		BG					
115			58	100	BG					
			59		BG					
			60		BG					
120										

Monitoring Well 007G04UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *283.73 feet msl*
Started at *0900 on 2-09-95*	TOC Elevation: *283.39 feet msl*
Completed at *0910 on 2-16-95*	Depth to Groundwater: *29.67 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *253.92 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *145 feet*
Geologist: *Jack Carmichael*	Well Screen: *124.9 to 134.9 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			61		BG			Sand, very fine to fine, clayey with lignitic chips, light brownish gray to grayish brown, clayey zones are stiff, wet.	
			62		BG				
125			63	100	BG				
			64		BG				
			65		BG				
130			66		BG		SC		
			67		BG				
135			68	120	BG			Sand, very fine to fine, lignitic, light brownish gray to grayish brown, cohesive in clayey zones, wet.	
			69		BG			Lignitic, dusky brown, hard.	
			70		BG				
140			71		BG			Clay, silty, traces of sand, laminated dark brownish gray, color changes below 141', stiff.	143.7
			72		BG		CL		
145			73	100	BG			End of boring at 145'.	138.7
150									
155									
160									

WELL DIAGRAM



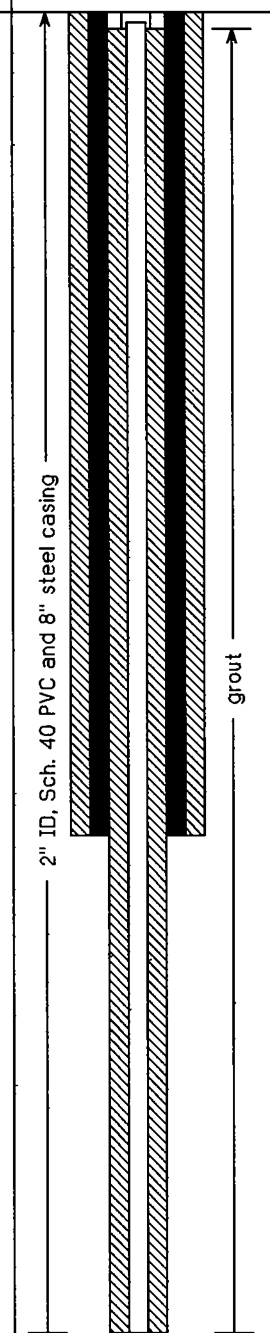
EnSafe (SM)

Monitoring Well 007G05UC

Project: *NSA Memphis*	Location: *Millington, TN Building N-126*
Project No.: *0094*	Surface Elevation: *282.67 feet msl*
Started at *on 2-09-95*	TOC Elevation: *282.39 feet msl*
Completed at *on 2-21-95*	Depth to Groundwater: *N/A feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *N/A feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *136 feet*
Geologist: *Jack Carmichael*	Well Screen: *124.8 to 134.8 feet*

DEPTH IN FEET	SAMPLE NO.	% RECOVERY	PID (ppm)	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
	1		BG		Clayey silt, moderate brown to yellowish brown, trace of organics.	
	2		BG			
5		75				
	3		BG			
	4		BG			
10	5	60	BG			
	6		BG			
	7		BG			
15		100			Clayey silt, dark yellowish brown, stiff, hard.	
	8		BG	ML		
	9		BG			
20	10	90	BG			
	11		BG			
	12		BG			
25						
	13		BG			
	14		BG			
30	15	90	BG			
	16		BG			250.2
	17		BG		Sandy clay, fine, medium light brown, soft, wet. Contact of Fluvial Deposits (33'-76') estimated at 33'.	
35		90				
	18		BG	SC	Silty sand, medium, light brown, grayish orange to yellow gray.	
	19		BG			
40	20		BG			

WELL DIAGRAM



ENSAFE (SM)

Monitoring Well 007G05UC

Project: *NSA Memphis*	Location: *Millington, TN Building N-126*
Project No.: *0094*	Surface Elevation: *282.67 feet msl*
Started at *on 2-09-95*	TOC Elevation: *282.39 feet msl*
Completed at *on 2-21-95*	Depth to Groundwater: *N/A feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *N/A feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *136 feet*
Geologist: *Jack Carmichael*	Well Screen: *124.8 to 134.8 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			21		BG		SC	Silty sand, medium, yellowish orange to light brown.	
			22		BG				
45									237.7
			23		BG		SP	Sand, medium, micaceous, yellowish orange to light brown.	
			24		BG			Sand, medium, grayish orange, micaceous.	
50			25		BG				
			26		BG				
			27		BG				
55				60					
			28		BG				
			29		BG				
60			30		BG				
			31		BG				
			32		BG				
65									217.2
			33		BG		GP	Gravelly sand, coarse to very coarse, dark yellowish orange.	
			34		BG				
70			35		BG				
			36		BG				
			38		BG				
75				87.5					
			39		BG		SC	Silty sand, fine, brownish gray, with thin dark yellow clay lenses. Contact of Cockfield Formation estimated at 76'.	206.7
			40		BG				
80			41		BG				

WELL DIAGRAM

2" ID, Sch. 40 PVC and 8" steel casing

grout

EnSafe (SM)

Monitoring Well 007G05UC

Project: *NSA Memphis*	Location: *Millington, TN Building N-126*
Project No.: *0094*	Surface Elevation: *282.67 feet msl*
Started at *on 2-09-95*	TOC Elevation: *282.39 feet msl*
Completed at *on 2-21-95*	Depth to Groundwater: *N/A feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *N/A feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *136 feet*
Geologist: *Jack Carmichael*	Well Screen: *124.8 to 134.8 feet*

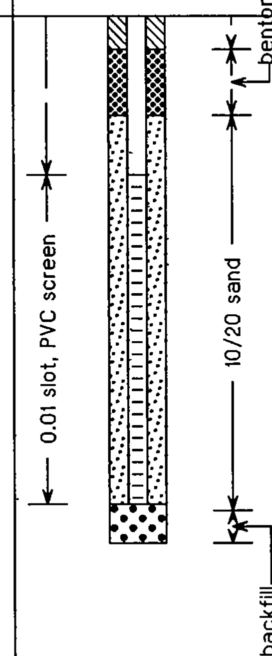
DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)	WELL DIAGRAM
			42		BG					
			43		BG					
85			44		BG					
			45		BG					
90			46		BG					
			47		BG					
			48		BG					
95				80						
			49		BG					
			50		BG					
100			51		BG		SC	Sand, fine, brownish gray with dark yellow brown clay lenses.		2" ID, Sch. 40 PVC and 8" steel casing; grout
			52		BG					
			53		BG					
105			54		BG					
			56		BG					
110			57		BG					
			58		BG					
			59		BG					
115				90						
			60		BG					
			61		BG					
120			62		BG					

Monitoring Well 007G05UC

Project: *NSA Memphis*	Location: *Millington, TN Building N-126*
Project No.: *0094*	Surface Elevation: *282.67 feet msl*
Started at *on 2-09-95*	TOC Elevation: *282.39 feet msl*
Completed at *on 2-21-95*	Depth to Groundwater: *N/A feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *N/A feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *136 feet*
Geologist: *Jack Carmichael*	Well Screen: *124.8 to 134.8 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			63		BG			Clay, dusky brown, waxy, from 119' to 119.5'. Sand, fine, brownish gray with clay lenses described above.	
			64		BG		SC		
125			65		BG				
			66		BG				154.7
130			67		BG			Clay, dusky brown, waxy, mixed with lignitic sand.	
			68		BG		CL		
			69		BG				
135				90				End of boring at 135'.	147.7
140									
145									
150									
155									
160									

WELL DIAGRAM



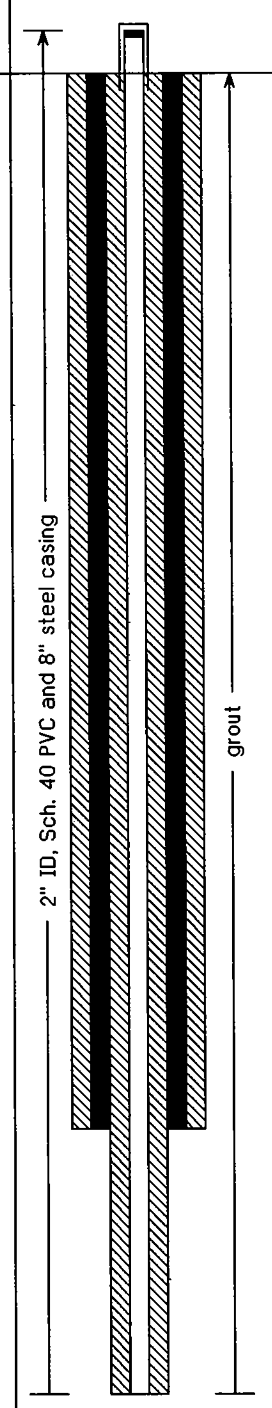
EnSafe

Monitoring Well 007G06UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *284.33 feet msl*
Started at *0820 on 2-10-95*	TOC Elevation: *286.49 feet msl*
Completed at *1010 on 2-14-95*	Depth to Groundwater: *28.25 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.24 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *101 feet*
Geologist: *Ben Brantley*	Well Screen: *83.8 to 93.8 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Fill and brick.	
				66				Clayey silt, moderate yellowish brown, mottled with yellow gray.	
5			1		BG				
			2		BG				
			3		BG				
10				70					
			4		BG				
			5		BG				
15			6	70	BG				
			7		BG		ML		
			8		BG				
20									
			9		BG				
			10		BG				
								Clayey silt, olive brown to olive gray, hard, stiff.	
25			11	60	BG				
			12		BG				
			13		BG			Clayey silt, light brown to yellowish brown, medium stiff.	
30									
			14		BG				
				85					
			15		BG				
									250.3
35			16		BG			Silty clayey sand, fine to very fine, yellowish orange to reddish brown.	
			17		BG		SC	Contact of Fluvial Deposits (36'-78') estimated at 36'.	
			18		BG				
40									

WELL DIAGRAM



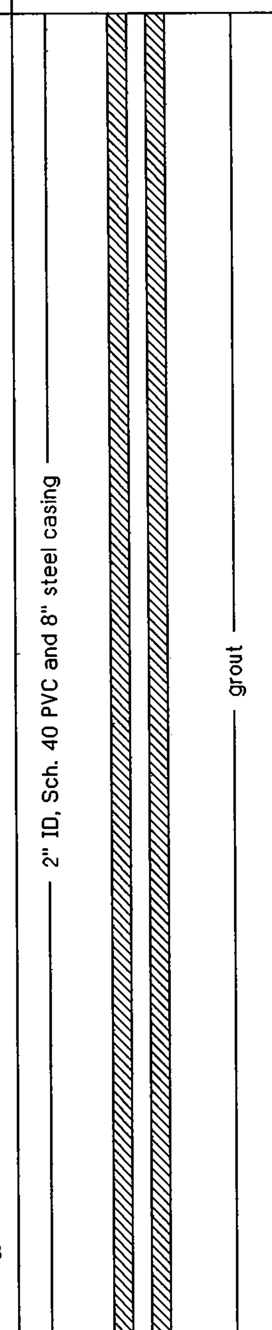
EnSafe (SM)

Monitoring Well 007G06UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *284.33 feet msl*
Started at *0820 on 2-10-95*	TOC Elevation: *286.49 feet msl*
Completed at *1010 on 2-14-95*	Depth to Groundwater: *28.25 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.24 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *101 feet*
Geologist: *Ben Brantley*	Well Screen: *83.8 to 93.8 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			19		BG				
			20		BG				
45			21	54	BG			Silty sand, very fine to fine, traces of clay casts, grayish orange to pale yellowish orange.	
			22		BG		SC		
			23		BG				
50									
			24		BG				
			25		BG				
55			26	100	BG			Sand, fine to coarse, pale yellowish brown to moderate yellowish brown.	229.3
			27		BG				
			28		BG				
60									
			29		BG				
			30		BG				
65			31	70	BG				
			32		BG		GP		
			33		BG				
70									
			34		BG				
			35		BG				
75			36	100	BG				
			37		BG			Silt,clayey, finely laminated, pale yellowish orange to dark yellowish orange.	206.8
			38		BG		SC		
80									

WELL DIAGRAM



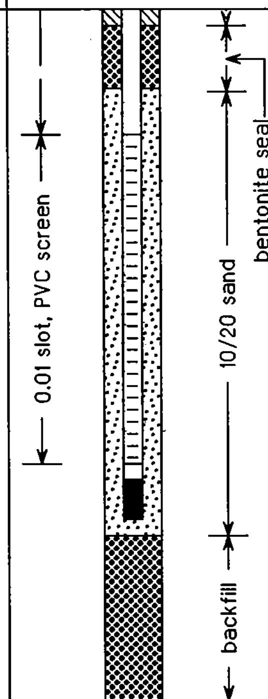
EnSafe (SM)

Monitoring Well 007G06UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *284.33 feet msl*
Started at *0820 on 2-10-95*	TOC Elevation: *286.49 feet msl*
Completed at *1010 on 2-14-95*	Depth to Groundwater: *28.25 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *258.24 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *101 feet*
Geologist: *Ben Brantley*	Well Screen: *83.8 to 93.8 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			39		BG		SC	Contact of Cockfield Formation estimated at 78'. Silty clay with fine sand, light brownish gray to grayish brown, micaceous, soft to stiff, moist.	
			40		BG				
85			41		BG				
				109					
			42		BG				
			43		BG				
90			44		BG				
			45		BG				190.3
95			46		BG		CL	Clay, interbedded very fine sand with silt, becoming more waxy.	
				120					
			47		BG				
			48		BG				
100			49	120	BG				183.3
								End of boring at 101'.	
105									
110									
115									
120									

WELL DIAGRAM

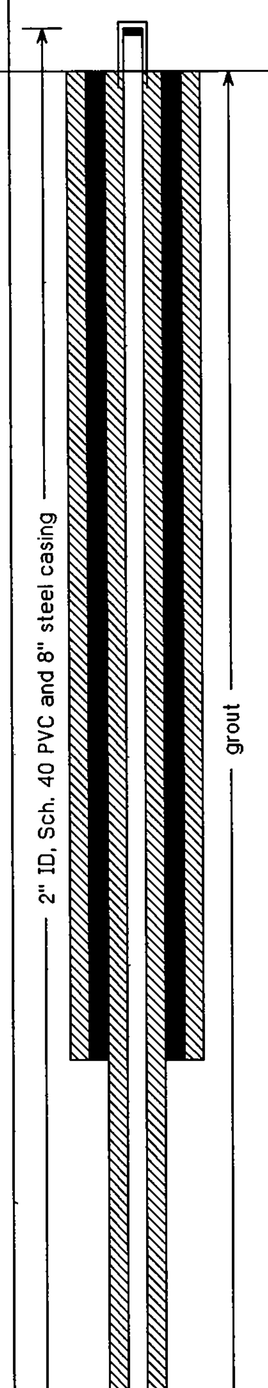


Monitoring Well 007G07UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *281.83 feet msl*
Started at *1750 on 2-10-95*	TOC Elevation: *283.94 feet msl*
Completed at *on 2-22-95*	Depth to Groundwater: *27.99 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *255.95 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *105 feet*
Geologist: *Ben Brantley and David Ladd*	Well Screen: *92.4 to 102.4 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Clayey silt, moderate yellowish brown, organics, mottled with yellowish gray silt.	
			1		0.4				
			2		BG				
5				125					
			3		BG				
			4		BG				
10			5	70	BG				
			6		BG				
			7		BG				
15				80				Clayey silt, light olive gray to olive brown, soft, moist.	
			8		BG				
			9		BG		ML		
20			10		BG				
			11		BG				
			12		BG				
25				65					
			13		BG				
			14		BG			Silty clay, light brown to moderate yellowish brown.	
30			15		BG				
			16		BG				
			17		BG			Contact of Fluvial Deposits (34'-74') estimated at 34'.	
35				90					246.3
			18		BG		SC	Silty sand, moderate yellowish brown to dark yellowish orange, stained reddish brown.	
			19		BG		SP		242.8
40									

WELL DIAGRAM



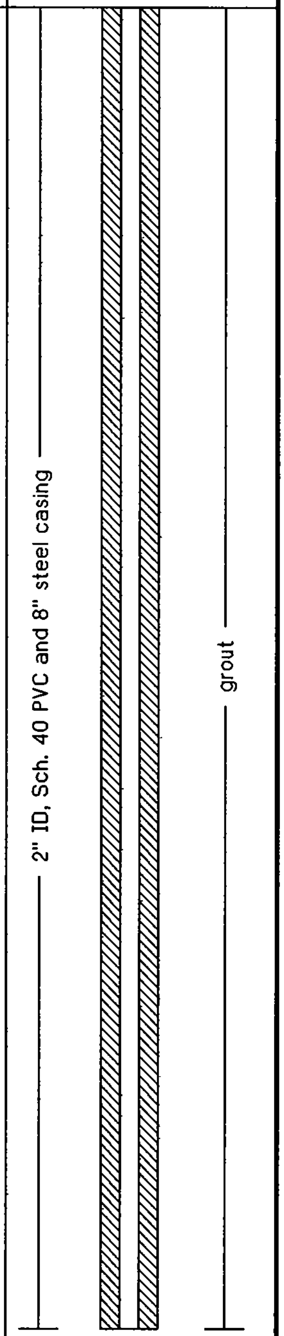
EnSafe

Monitoring Well 007G07UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *281.83 feet msl*
Started at *1750 on 2-10-95*	TOC Elevation: *283.94 feet msl*
Completed at *on 2-22-95*	Depth to Groundwater: *27.99 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *255.95 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *105 feet*
Geologist: *Ben Brantley and David Ladd*	Well Screen: *92.4 to 102.4 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			20		BG			Sand, fine to medium, silty, grayish orange to dark yellowish orange, at 39' there is some gray sand.	
			21		BG				
45			22	110	BG				
			23		BG				
			24		BG				
50			25		BG		SP		
			26		BG				
55			27	90	BG				
			28		BG				
			29		BG				
60									221.8
			30		BG			Sand and gravel, fine to very coarse grained, grayish orange to dark yellowish orange.	
			31		BG				
65			32	110	BG				
			33		BG				
			34		BG		GP		
70			35		BG			Sand with interdisbursed clay, fine to medium grained. Clay is pinkish gray, moist.	
			36		BG			Contact of Cockfield Formation estimated at 74'.	
75			37	95	BG				
			38		BG				
									203.3
			39		BG		SC		
80									

WELL DIAGRAM



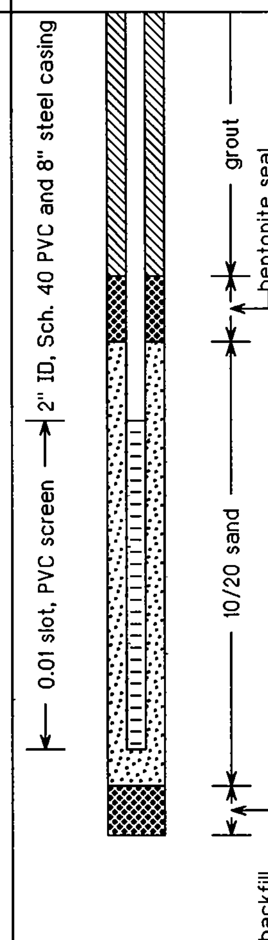
EnSafe (SM)

Monitoring Well 007G07UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *281.83 feet msl*
Started at *1750 on 2-10-95*	TOC Elevation: *283.94 feet msl*
Completed at *on 2-22-95*	Depth to Groundwater: *27.99 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *255.95 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *105 feet*
Geologist: *Ben Brantley and David Ladd*	Well Screen: *92.4 to 102.4 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			40		BG			Sand, interbedded with clay, grayish orange, then becomes silty sand, very fine grained, clay is dark yellowish orange.	
			41		BG				
85			42	100	BG			Silty sand, with interbedded clay, very fine sand, dusky yellowish brown clay to moderate brown, mottled with light olive to olive gray sand.	
			43		BG				
			44		BG				
90			45		BG		SC		
			46		BG				
95			47	120	BG				
			48		BG				
			49		BG				
100			50		BG				179.8
			51		BG		CL	Clay, laminations of sand, dusky yellowish brown to moderate brown clay, light olive to olive gray sand, waxy.	
105			52	115	BG				176.8
								End of boring at 105'.	
110									
115									
120									

WELL DIAGRAM



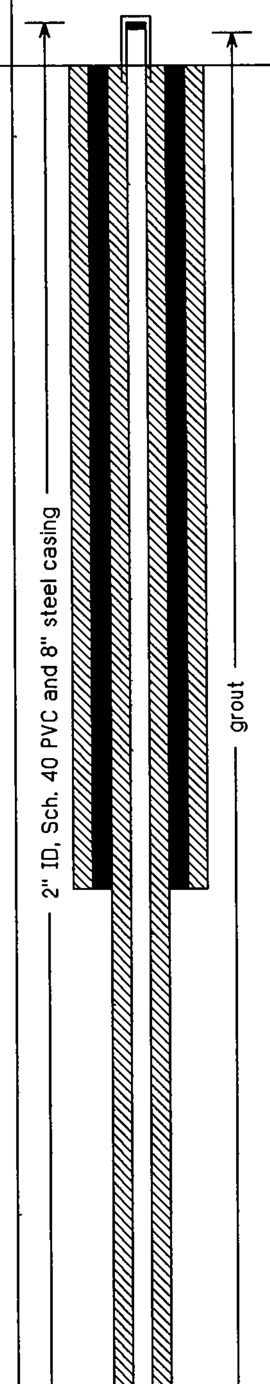
EnSafe

Monitoring Well 007G08UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *281.10 feet msl*
Started at *0900 on 2-11-95*	TOC Elevation: *283.10 feet msl*
Completed at *1210 on 2-24-95*	Depth to Groundwater: *26.00 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.15 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *126 feet*
Geologist: *David Ladd*	Well Screen: *115.7 to 125.7 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
								Clayey silt, yellowish brown, mottled yellowish gray.	
			1		BG				
			2		BG				
5				140	BG			Clayey silt, moderate brown, moist, soft.	
			3		BG				
			4		BG				
10			5	98	BG				
			6		BG				
			7		BG				
15				98					
			8		BG		ML		
								Clayey silt, olive gray, medium stiff to soft.	
			9		BG				
20			10		BG				
			11		BG			Silt, light olive gray with brown mottling.	
25				85				Silt, moderate to light brown, hard.	
			13		BG				
			14		BG				
30				80					
			15		BG				250.1
								Sandy silt, moderate yellowish brown.	
			16		BG		SC	Contact of Fluvial Deposits (31'-78') estimated at 31'.	
35			17	120	BG				
									245.1
			18		BG			Sand, fine, dark yellowish orange mottled with grayish orange, silty.	
			19		BG		SP	Sand, pale yellowish brown.	
40									

WELL DIAGRAM



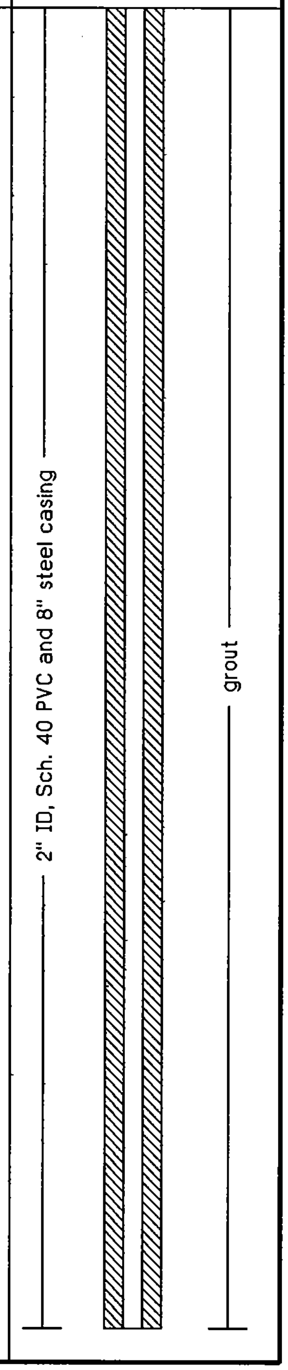
EnSafe (SM)

Monitoring Well 007G08UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *281.10 feet msl*
Started at *0900 on 2-11-95*	TOC Elevation: *283.10 feet msl*
Completed at *1210 on 2-24-95*	Depth to Groundwater: *26.00 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.15 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *126 feet*
Geologist: *David Ladd*	Well Screen: *115.7 to 125.7 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			20		BG				
			21		BG				
45			22	80	BG			Sand, fine, grayish orange to dark yellowish orange, wet, scattered gravel.	
			23		BG				
			24		BG				
50			25		BG		SP		
			26		BG				
55			27	95	BG				
			28		BG				
60			29		BG				
			30		BG				
			31		BG				218.1
65			32	90	BG			Sand and gravel, fine to very coarse grained, grayish orange to dark yellowish orange, gravel.	
			33		BG				
70			34		BG		GP		
			35		BG				
			36		BG				
75			37	90	BG				205.1
			38		BG		SC	Sand, silty, very fine grained, dark yellowish orange mottled with light gray, wet.	
80			39		BG				

WELL DIAGRAM



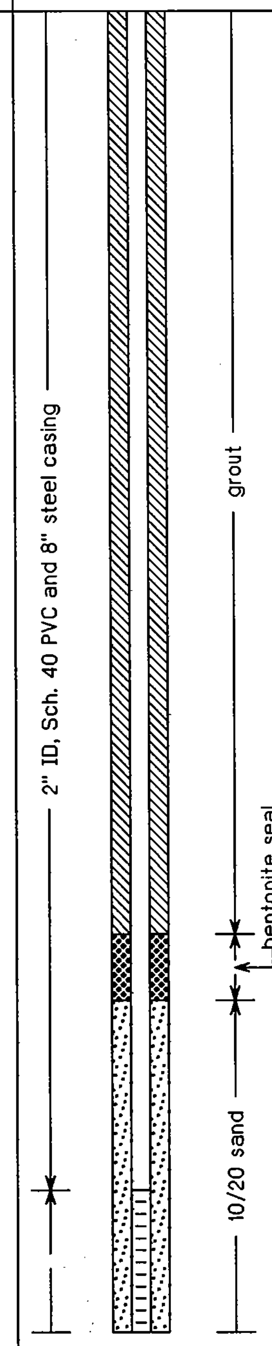
EnSafe (SM)

Monitoring Well 007G08UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *281.10 feet msl*
Started at *0900 on 2-11-95*	TOC Elevation: *283.10 feet msl*
Completed at *1210 on 2-24-95*	Depth to Groundwater: *26.00 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.15 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *126 feet*
Geologist: *David Ladd*	Well Screen: *115.7 to 125.7 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			40		BG			Contact of Cockfield Formation estimated at 78'.	
			41		BG			Sand, silty, very fine grained, dark yellowish orange to very pale orange.	
85			42	85	BG				
			43		BG			Sand, silty, very fine grained, dark yellowish orange mottled with light gray, interbedded with gray clay, wet from 94'-95'.	
			44		BG				
90									
			45		BG				
			46		BG				
95			47	100	BG			Sand with interbedded clay, very fine, dusky brown to moderate brown, mottled with light olive gray, rare marcasite nodules.	
			48		BG				
			49		BG				
100							SC		
			50		BG				
			51		BG				
105			52	110	BG				
			53		BG				
			54		BG				
110									
			55		BG				
			56		BG				
115			57	110	BG				
			58		BG				
			59		BG				
120									

WELL DIAGRAM



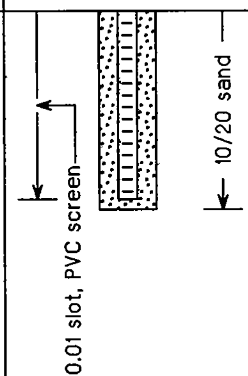
EnSafe (SM)

Monitoring Well 007G08UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *281.10 feet msl*
Started at *0900 on 2-11-95*	TOC Elevation: *283.10 feet msl*
Completed at *1210 on 2-24-95*	Depth to Groundwater: *26.00 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *257.15 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *126 feet*
Geologist: *David Ladd*	Well Screen: *115.7 to 125.7 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			60		BG		SC		
									159.1
			61		BG		CL	Clay, laminations of sand, dusky yellowish brown to moderate brown clay, light olive to olive brown sand, waxy.	
125			62	105	BG				
									155.1
								End of boring at 126'.	
130									
135									
140									
145									
150									
155									
160									

WELL DIAGRAM



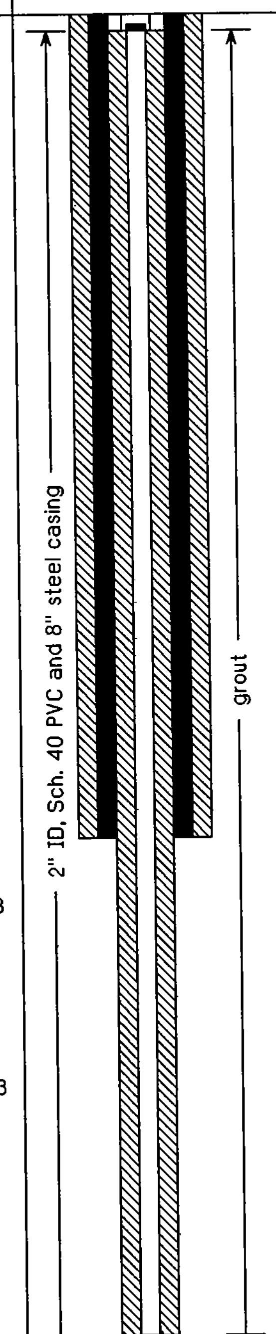
EnSafe (SM)

Monitoring Well 007G09UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *282.81 feet msl*
Started at *1550 on 2-11-95*	TOC Elevation: *282.55 feet msl*
Completed at *on 2-15-95*	Depth to Groundwater: *26.38 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *256.09 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *115 feet*
Geologist: *Ben Brantley*	Well Screen: *104.1 to 114.1 feet*

DEPTH IN FEET	SAMPLE NO.	% RECOVERY	PID (ppm)	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
					Clayey silt, moderate brown with yellow gray streaks, moist, soft.	
	1		BG			
5	2	100	BG			
	3		BG			
	4		BG			
10		70				
	5		BG			
	6		BG	ML		
15	7	100	BG			
	8		BG		Silty clay, reddish brown, stiff and plastic.	
	9		BG		Clayey silt, light brown with clay inclusions.	
20						
	10		BG			
	11		BG		Silty clay, moderate brown to reddish brown.	
25	12	95	BG			
	13		BG			255.8
					Clayey sand, fine, medium brown to reddish-brown.	
	14		BG	SC	Contact of Fluvial Deposits (28'-73') estimated at 28'.	
30						
	15		BG			
						250.3
	16		BG		Sand, fine, yellow orange to light brown.	
35	17	80	BG			
	18		BG	SP		
	19		BG		Sand, medium, yellowish gray, micaceous.	
40						

WELL DIAGRAM

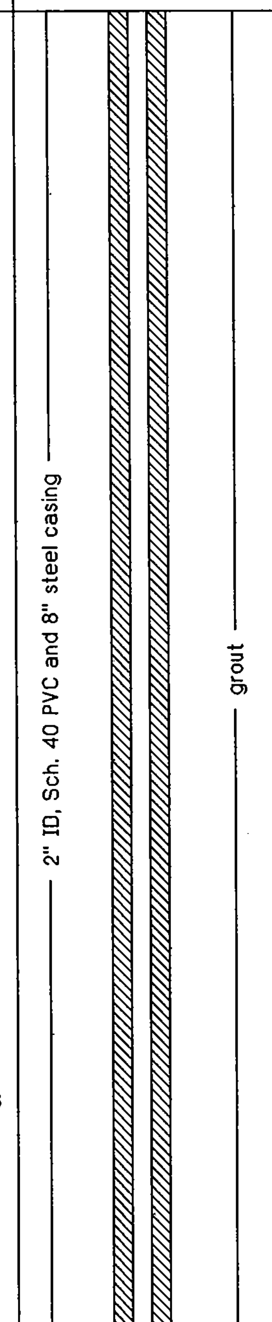


Monitoring Well 007G09UC

Project: NSA Memphis	Location: Millington, TN. Building N-126
Project No.: 0094	Surface Elevation: 282.81 feet msl
Started at 1550 on 2-11-95	TOC Elevation: 282.55 feet msl
Completed at on 2-15-95	Depth to Groundwater: 26.38 feet Measured: 3/31/95
Drilling Method: Rotasonic	Groundwater Elevation: 256.09 feet msl
Drilling Company: North Star Drilling	Total Depth: 115 feet
Geologist: Ben Brantley	Well Screen: 104.1 to 114.1 feet

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			20		BG				
			21		BG				
45			22	95	BG			Medium-grained sand, grayish-yellowish orange color.	
			23		BG				
			24		BG				
50			25		BG		SP		
			26		BG				
55			27		BG				
			28		BG				
			29		BG				
60			30		BG			Sand, coarse to gravelly, grayish orange to yellowish orange.	222.8
			31		BG				
65			32	90	BG				
			33		BG		GP		
			34		BG				
70			35		BG				
			36		BG			Silty sand, very fine, yellowish orange banded with yellowish gray.	209.8
75			37		BG			Contact of Cockfield Formation estimated at 73'.	
			38		BG		SC	Clayey silty sand, grayish brown, dusky brown layers of clay with light gray sand.	
			39		BG				
80									

WELL DIAGRAM



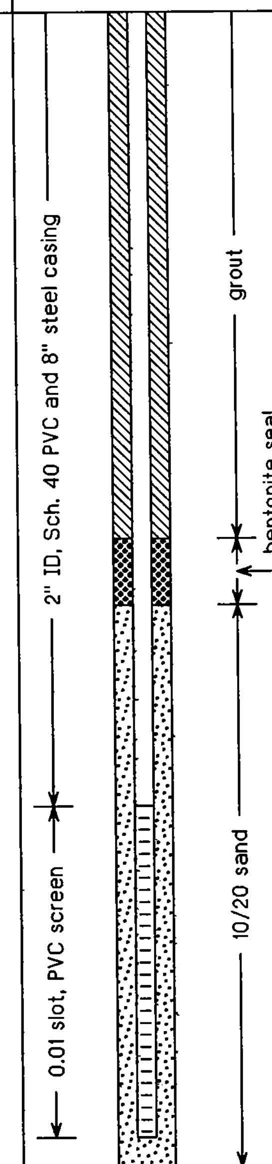
EnSafe (SM)

Monitoring Well 007G09UC

Project: *NSA Memphis*	Location: *Millington, TN. Building N-126*
Project No.: *0094*	Surface Elevation: *282.81 feet msl*
Started at *1550 on 2-11-95*	TOC Elevation: *282.55 feet msl*
Completed at *on 2-15-95*	Depth to Groundwater: *26.38 feet* Measured: *3/31/95*
Drilling Method: *Rotasonic*	Groundwater Elevation: *256.09 feet msl*
Drilling Company: *North Star Drilling*	Total Depth: *115 feet*
Geologist: *Ben Brantley*	Well Screen: *104.1 to 114.1 feet*

DEPTH IN FEET	LITHOLOGIC SAMPLE	ANALYTICAL SAMPLE	SAMPLE NO.	% RECOVERY	PID (ppm)	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION	ELEV. (ft-msl)
			40		BG				
			41		BG				
85			42	95	BG				
			43		BG				
			44		BG				
90			45		BG				
			46		BG				
95			47		BG				
			48		BG		SC		
			49		BG				
100			50		BG				
			51		BG				
105			52	90	BG				
			53		BG				
			54		BG				
110			55		BG				170.8
			56		BG		CL	Clay, dusky brown, hard and waxy, with medium gray sand lenses.	
115			57	110	BG			End of boring at 115'.	167.8
120									

WELL DIAGRAM



Appendix C

Geotechnical Data

TRI STATE
TESTING SERVICES, INC.

Measurement of Hydraulic Conductivity

Client: EnSafe/Allen & Hoshall

Date of Report: 03/17/95 Project No.: E-2-837

Project Name: NAS Memphis, Tennessee

Sample I.D.: 07S0008127 - Soil Boring S0008 ; Depth 12.7'

Soil Description: Dark Brown Clay with Silt & fine sand lenses

	Pre-Test	Post Test
Wet Density (Lbs/ft^3)	104.9	109.7
Dry Density (Lbs/ft^3)	81.1	82.0
Moisture (% Dry Wt)	29.3	33.7
Porosity (n)	.497	.504
Degree of Saturation (%)	.91	1.0

Permeability

Temperature Correction, $R_t = 1.053$

$K_1 = 8.7 \times 10^{-7}$ cm/sec
$K_2 = 7.6 \times 10^{-7}$ cm/sec
$K_3 = 8.4 \times 10^{-7}$ cm/sec
$K_4 = 8.5 \times 10^{-7}$ cm/sec

Coefficient of Permeability, $K_{20} = 8.7 \times 10^{-7}$ cm/sec

Tested in accordance with Method 9100 of Test Methods for evaluation Solid Waste, Third Addition (SW-846) and in general accordance with ASTM D-5084-90.

Lab No. P-95-0017 Reviewed By: David D. McCray

David D. McCray

6756 Buckles Cove Memphis, TN 38133 901-385-1199 FAX 901-386-6614

TRI STATE
TESTING SERVICES, INC.

Measurement of Hydraulic Conductivity

Client: EnSafe/Allen & Hoshall

Date of Report: 03/17/95 Project No.: E-2-837

Project Name: NAS Memphis, Tennessee

Sample I.D.: 07S0001112 Soil Boring 1; Depth 112'

Soil Description: Dark Brown Clay with Silt & fine sand lenses running horizontal

	Pre-Test	Post Test
Wet Density (Lbs/ft^3)	105.6	108.0
Dry Density (Lbs/ft^3)	80.2	78.6
Moisture (% Dry Wt)	31.7	37.4
Porosity (n)	.506	.516
Degree of Saturation (%)	.96	1.0

Permeability

Temperature Correction, $R_t = 1.043$

$K_1 = 3.7 \times 10^{-8}$ cm/sec
$K_2 = 4.2 \times 10^{-8}$ cm/sec
$K_3 = 3.9 \times 10^{-8}$ cm/sec
$K_4 = 3.9 \times 10^{-8}$ cm/sec

Coefficient of Permeability, $K_{20} = 4.1 \times 10^{-8}$ cm/sec

Tested in accordance with Method 9100 of Test Methods for evaluation Solid Waste, Third Addition (SW-846) and in general accordance with ASTM D-5084-90.

Lab No. P-95-0018 Reviewed By: [signature]
David D. McCray

6756 Buckles Cove Memphis, TN 38133 901-385-1199 FAX 901-386-6614

TRI STATE
TESTING SERVICES, INC.

Measurement of Hydraulic Conductivity

Client: EnSafe/Allen & Hoshall

Date of Report: 03/17/95 Project No.: E-2-837

Project Name: NAS Memphis, Tennessee

Sample I.D.: 007S000177 Soil Boring 1; Depth 77'

Soil Description: Yellow & light Gray Silt with fine sand

	Pre-Test	Post Test
Wet Density (Lbs/ft^3)	118.6	120.8
Dry Density (Lbs/ft^3)	101.0	101.9
Moisture (% Dry Wt)	17.4	18.6
Porosity (n)	.397	.383
Degree of Saturation (%)	.97	1.0

Permeability

Temperature Correction, $R_t = 1.048$

$K_1 = 6.7 \times 10^{-5}$ cm/sec
$K_2 = 6.4 \times 10^{-5}$ cm/sec
$K_3 = 6.8 \times 10^{-5}$ cm/sec
$K_4 = 6.2 \times 10^{-5}$ cm/sec

Coefficient of Permeability, $K_{20} = 6.8 \times 10^{-5}$ cm/sec

Tested in accordance with Method 9100 of Test Methods for evaluation Solid Waste, Third Addition (SW-846) and in general accordance with ASTM D-5084-90.

Lab No. P-95-0019 Reviewed By: David D. McCray
David D. McCray

6756 Buckles Cove Memphis, TN 38133 901-385-1199 FAX 901-386-6614

TRI STATE TESTING SERVICES, INC.

Measurement of Hydraulic Conductivity

Client: EnSafe/Allen & Hoshall

Date of Report: 03/13/95 Project No.: E-2-837

Project Name: NAS Memphis, Tennessee

Sample I.D.: 007S0003117 Soil Boring 3 ; Depth 117'

Soil Description: Dark Brown Clay with Silt & fine sand lenses running horizontal

	Pre-Test	Post Test
Wet Density (Lbs/ft^3)	98.0	103.2
Dry Density (Lbs/ft^3)	75.3	73.8
Moisture (% Dry Wt)	30.1	39.9
Porosity (n)	.544	.554
Degree of Saturation (%)	.67	.95

Permeability

Temperature Correction, R_t = 1.086

K_1 = 1.4 X 10^{-8} cm/sec
K_2 = 1.4 X 10^{-8} cm/sec
K_3 = 1.7 X 10^{-8} cm/sec
K_4 = 1.3 X 10^{-8} cm/sec

Coefficient of Permeability, K_{20} = 1.6 X 10^{-8} cm/sec

Tested in accordance with Method 9100 of Test Methods for evaluation Solid Waste, Third Addition (SW-846) and in general accordance with ASTM D-5084-90.

Lab No. P-95-0014 Reviewed By: David D. McCray

David D. McCray

6756 Buckles Cove Memphis, TN 38133 901-385-1199 FAX 901-386-6614

TRI STATE
TESTING SERVICES, INC.

Measurement of Hydraulic Conductivity

Client: EnSafe/Allen & Hoshall

Date of Report: 03/13/95 Project No.: E-2-837

Project Name: NAS Memphis, Tennessee

Sample I.D.: 007S000922 Soil Boring 9; Depth 22'

Soil Description: Brown Silty Clay

	Pre-Test	Post Test
Wet Density (Lbs/ft^3)	119.9	121.1
Dry Density (Lbs/ft^3)	94.0	95.4
Moisture (% Dry Wt)	27.5	26.9
Porosity (n)	.430	.420
Degree of Saturation (%)	.963	.980

Permeability

Temperature Correction, $R_t = 1.056$

$K_1 = 6.9 \times 10^{-7}$ cm/sec
$K_2 = 1.0 \times 10^{-6}$ cm/sec
$K_3 = 9.7 \times 10^{-7}$ cm/sec
$K_4 = 9.2 \times 10^{-7}$ cm/sec

Coefficient of Permeability, $K_{20} = 9.5 \times 10^{-7}$ cm/sec

Tested in accordance with Method 9100 of Test Methods for evaluation Solid Waste, Third Addition (SW-846) and in general accordance with ASTM D-5084-90.

Lab No. P-95-0016 Reviewed By: David D. McCray

6756 Buckles Cove Memphis, TN 38133 901-385-1199 FAX 901-386-6614

TRI STATE
TESTING SERVICES, INC.

Report of Laboratory Analysis

EnSafe/Allen & Hoshall
5720 Summer Trees Drive, Suite 8
Memphis, Tennessee 38134

Project No.: E-2-837
Date: 17 March '95
Sheet 1 of 1

Project: NAVY CLEAN Memphis, Tennessee

Sample Identification	07S0008127	07S0001112	007S000177
Percent Moisture (as received)	29.3%	31.7%	17.4%
Bulk Density Wet (as received) LBS/ft^3	104.9	105.6	118.6
Bulk Density Dry (as received) LBS/ft^3	81.1	80.2	101.0
Specific Gravity	2.65	2.65	2.63

Reviewed by: David D. McCray
David D. McCray

6756 Buckles Cove Memphis, TN 38133 901-385-1199 FAX 901-386-6614

TRI STATE
TESTING SERVICES, INC.

Report of Laboratory Analysis

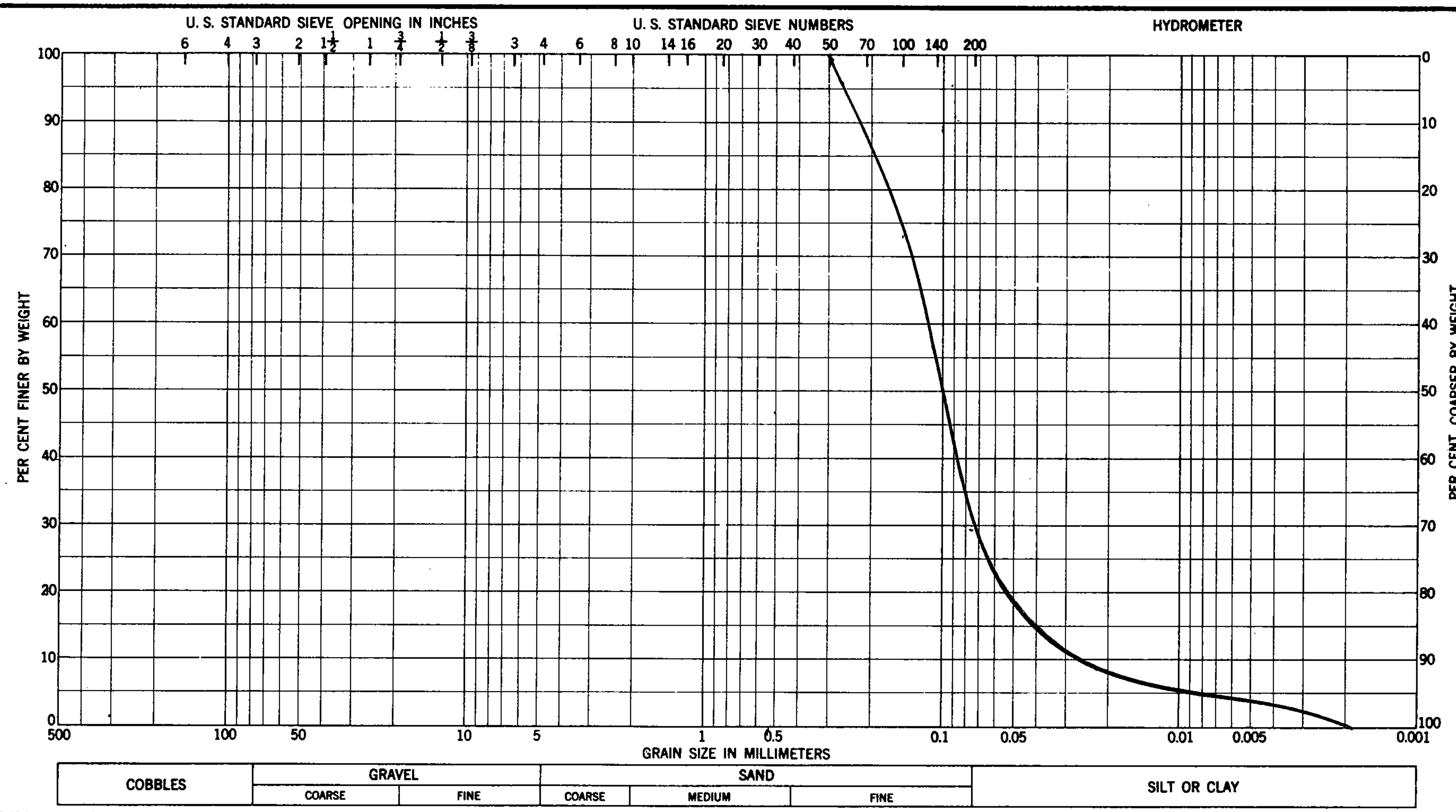
EnSafe/Allen & Hoshall
5720 Summer Trees Drive, Suite 8
Memphis, Tennessee 38134

Project No.: E-2-837
Date: 13 March '95
Sheet 1 of 1

Project: NAVY CLEAN Memphis, Tennessee

Sample Identification	007S0003117	-NA- 008MW025	007S000922
Percent Moisture (as received)	30.1%	25.9%	27.5%
Bulk Density Wet (as received) LBS/ft^3	98.0	126.0	119.9
Bulk Density Dry (as received) LBS/ft^3	75.3	100.1	94.0
Specific Gravity	2.65	2.64	2.64

Reviewed by: David D. McCray



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
--	--	SM or SC	--	--	--	--

GRADATION CURVES

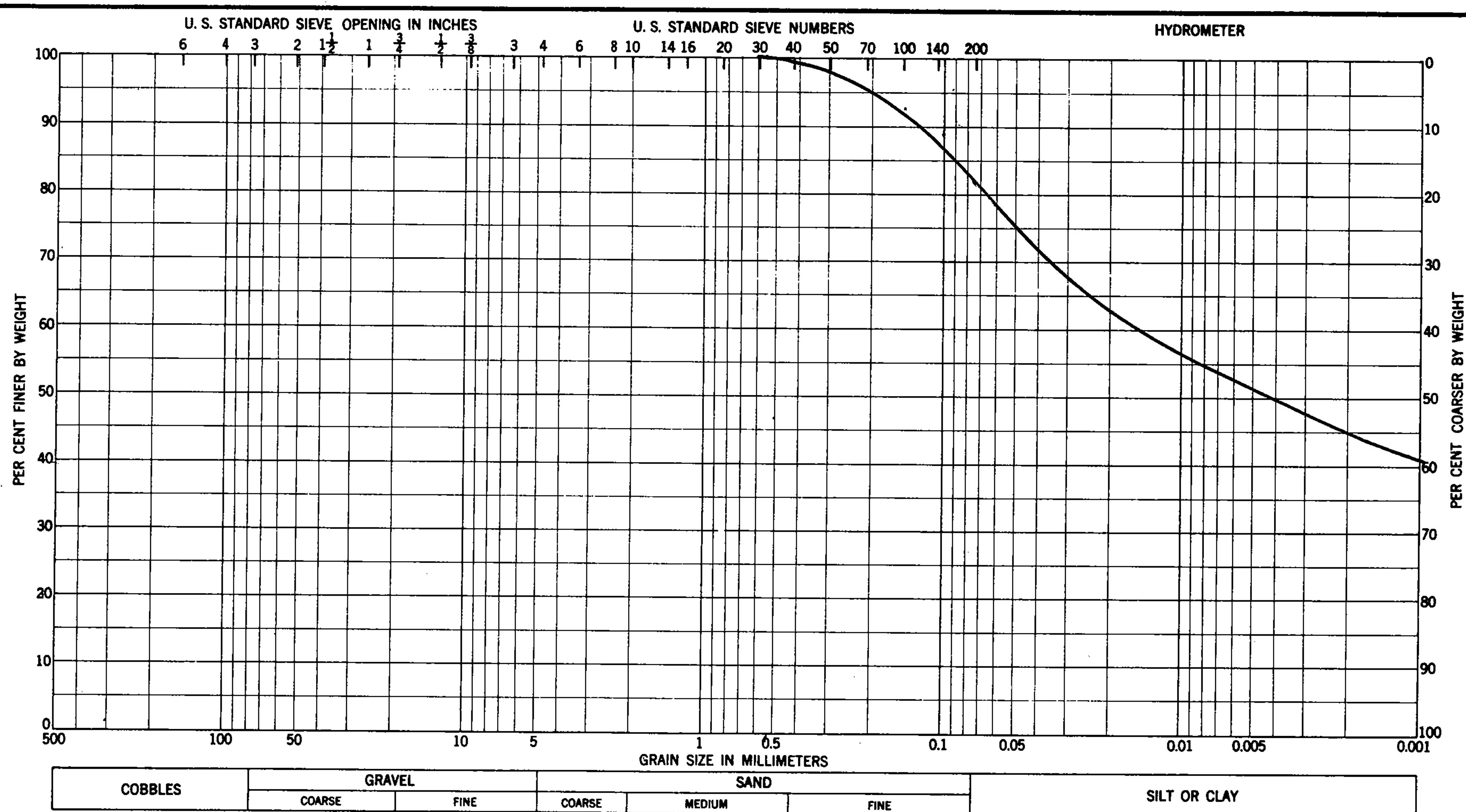
Project Naval Air Station
Memphis, Tennessee

Area

Boring No. Sample ID 007S000177

Date 03/14/95

TRI-STATE TESTING SERVICES, INC.



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
--	--	CL, ML, OL, MH, CH, OH	--	--	--	--
		(Depends on Atterberg Limits)				

Project Naval Air Station
Memphis, Tennessee

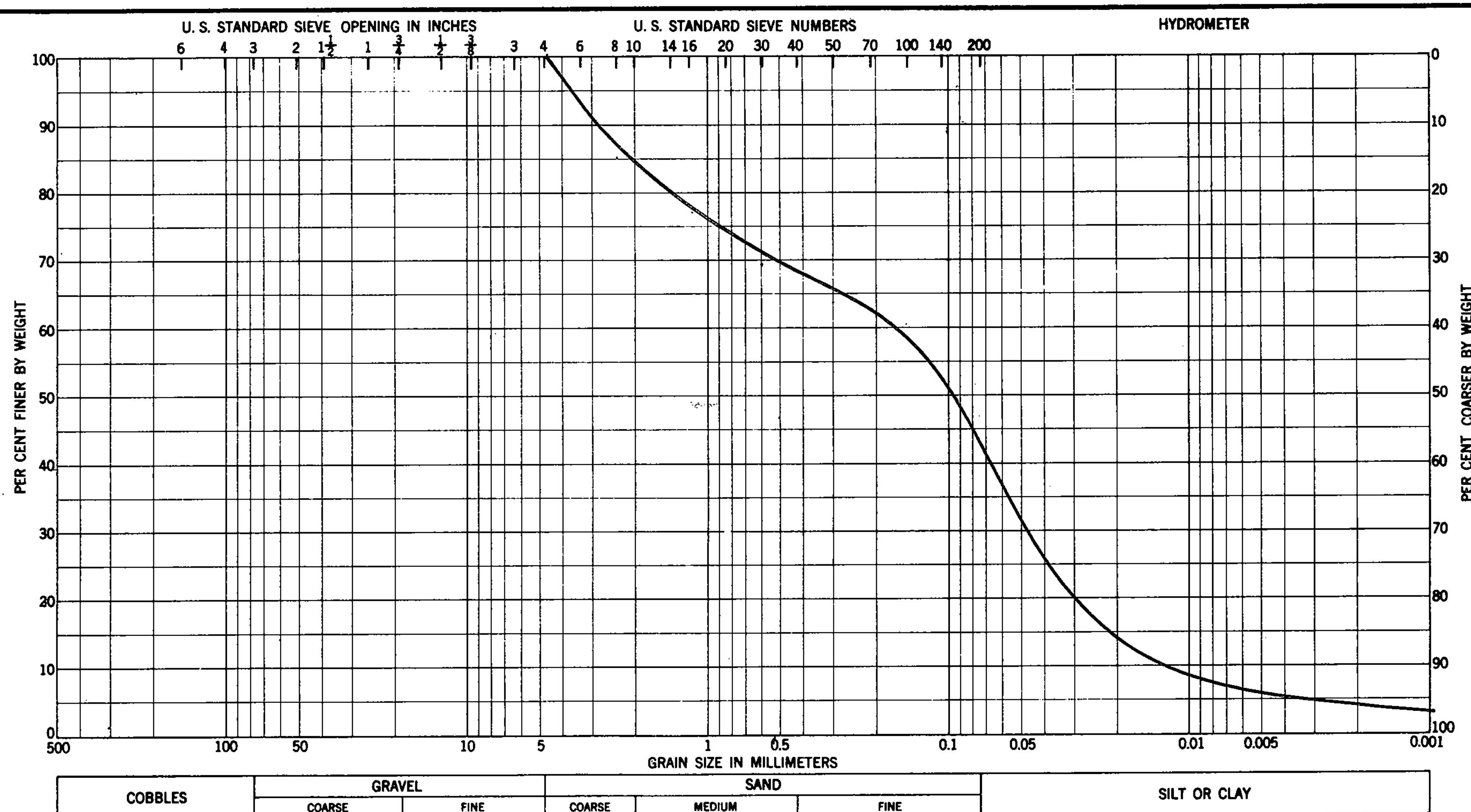
Area

Boring No. Sample ID 0750001112

Date 03/14/95

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
--	--	SM or SC	--	--	--	--

Project Naval Air Station
Memphis, Tennessee

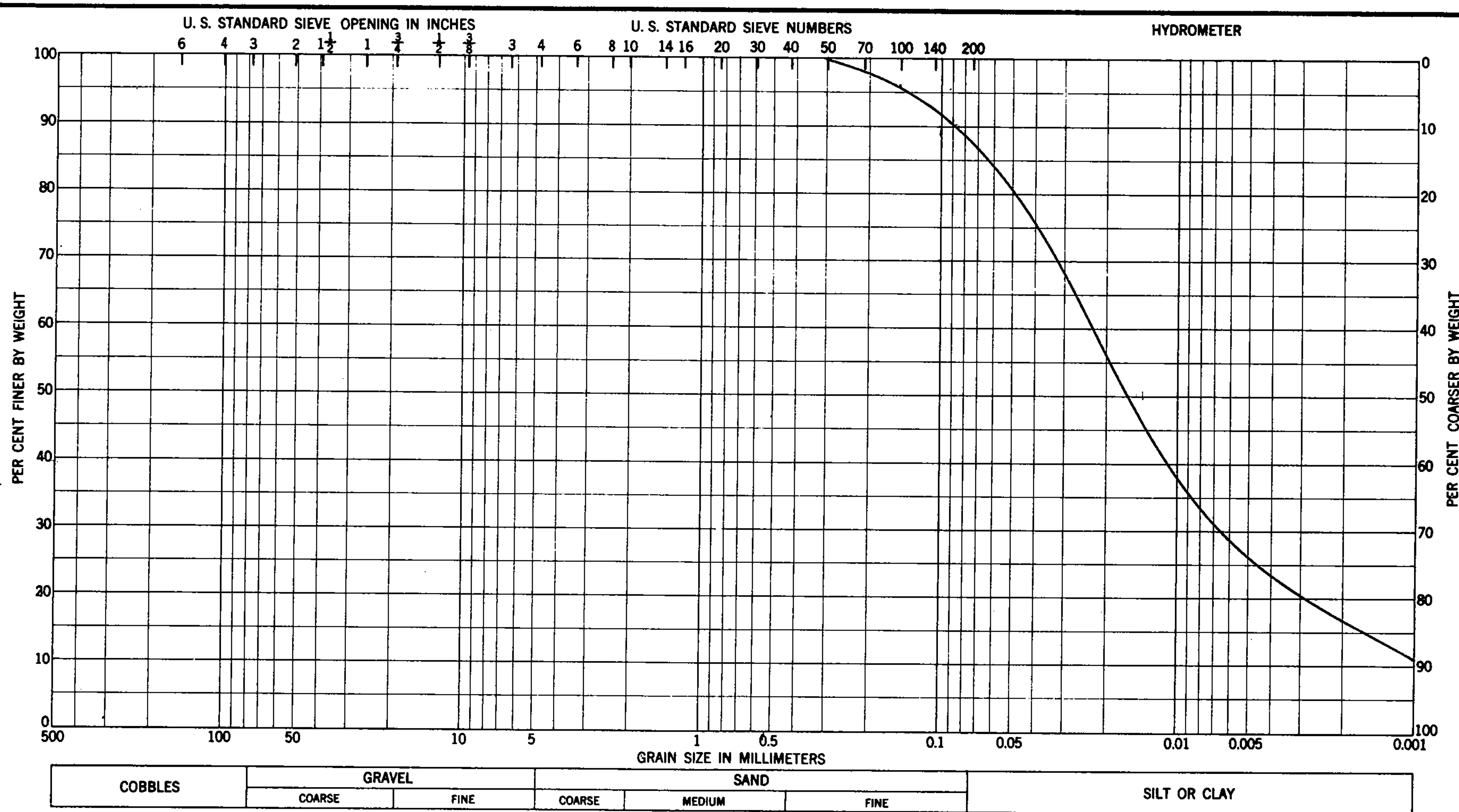
Area

Boring No. Sample ID 07S0008127

Date 03/14/95

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
--	--	ML, CL, OL, MH, CH, OH	--	--	--	--
		Depends on Atterberg Limits				

Project Naval Air Station
Memphis, Tennessee

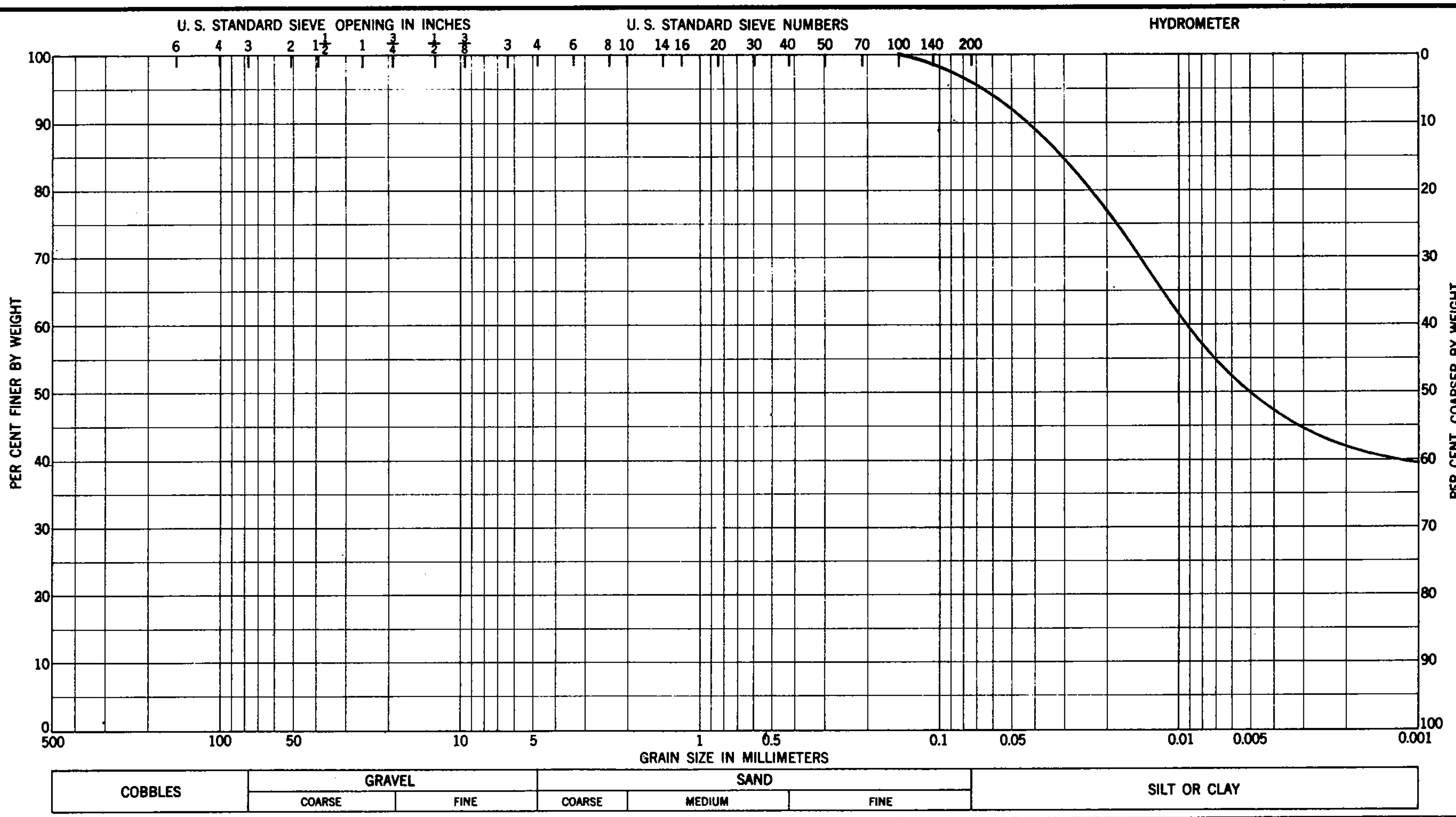
Area

Boring No. Sample ID 00750003117

Date 03/06/95

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
--	--	ML, CL, OL, MH, CH, or OH	--	--	--	--

Project Naval Air Station
Memphis, Tennessee

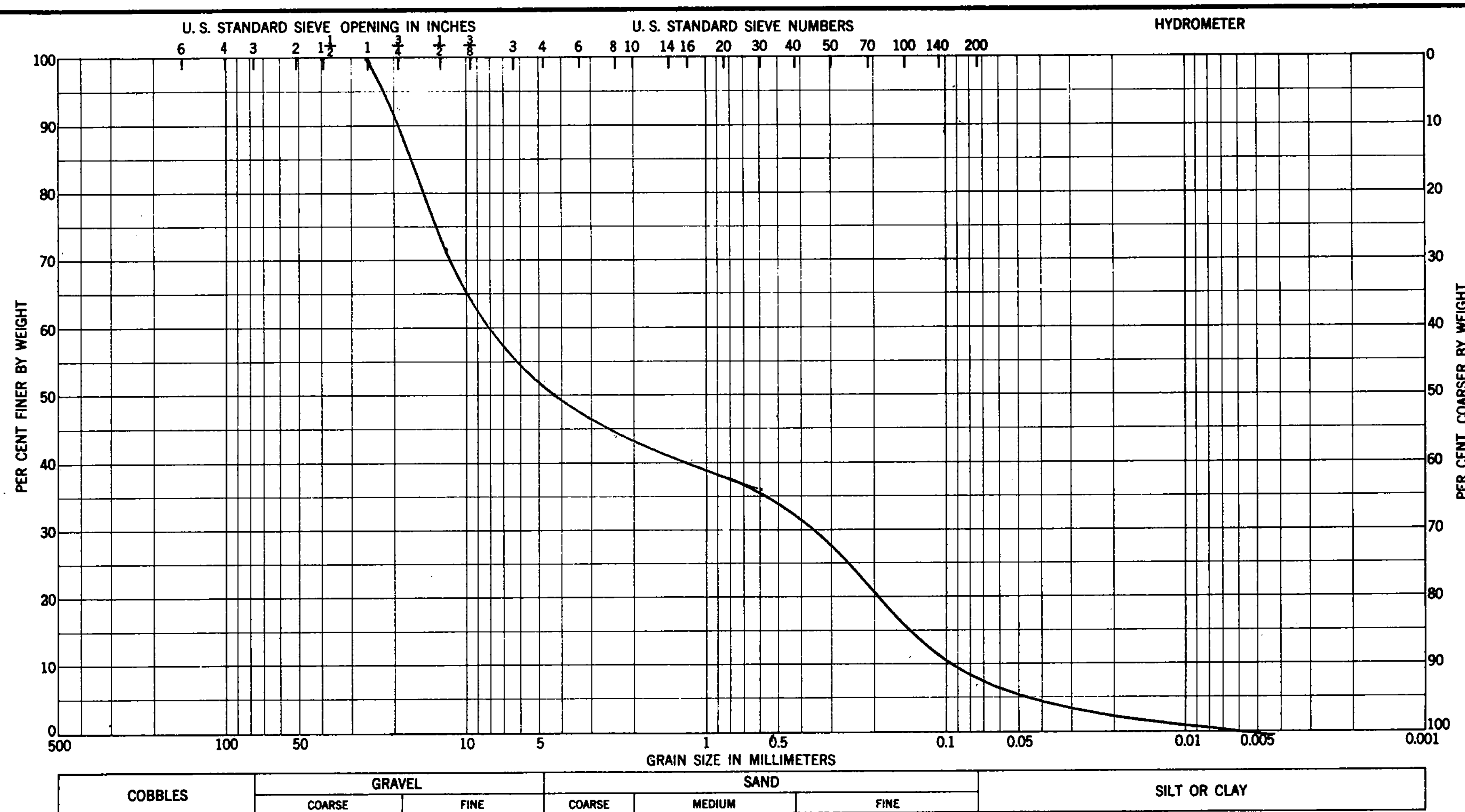
Area

Boring No. Sample ID 007S000922

Date 03/06/95

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.

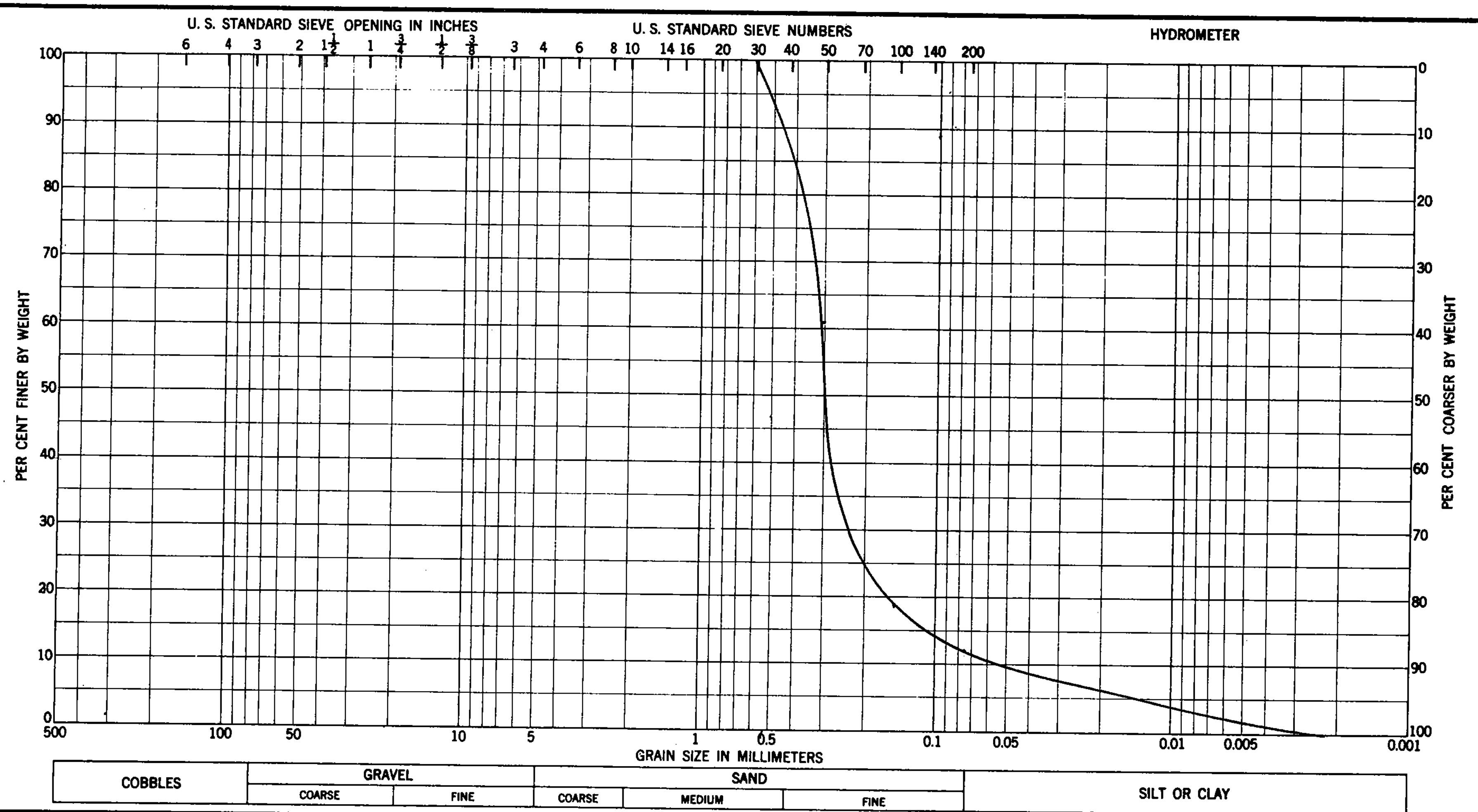


Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
--	--	SP-SM or SP-SC	--	--	--	-

Project	Naval Air Station Memphis, Tennessee
Area	
Boring No.	Sample ID 07S00275
Date	03/06/95

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
--	--	SP-SM or SP-SC	--	--	--	--

GRADATION CURVES

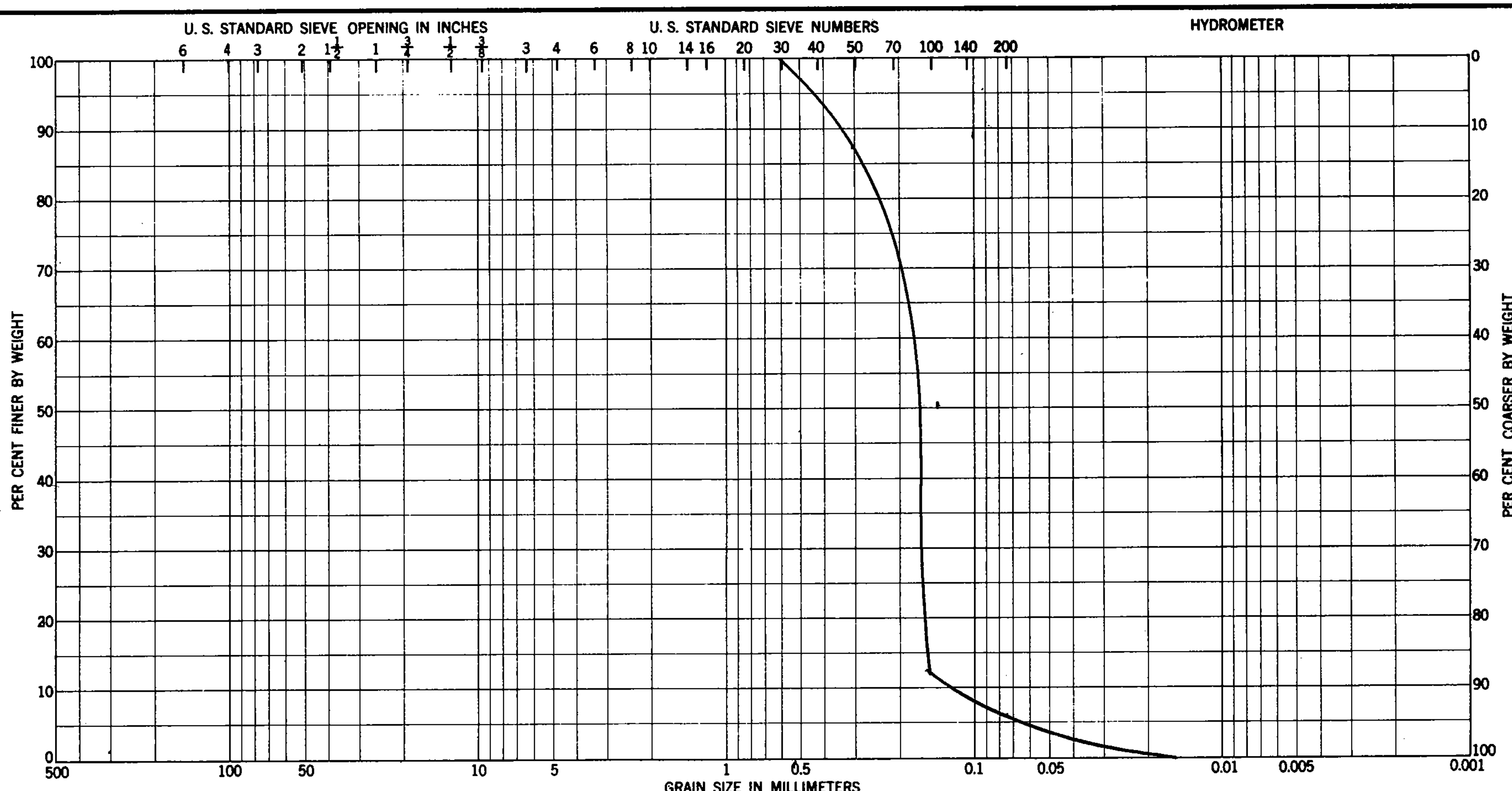
Project Naval Air Station
Memphis, Tennessee

Area

Boring No. Sample ID 07S000341

Date 03/06/95

TRI-STATE TESTING SERVICES, INC.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
--	--	SP-SM or SP-SC	--	--	--	--

GRADATION CURVES

Project Naval Air Station
Memphis, Tennessee

Area

Boring No. Sample ID 07S000346

Date 03/06/95

TRI-STATE TESTING SERVICES, INC.

5/96

TRI STATE
TESTING SERVICES, INC.

Measurement of Hydraulic Conductivity

Client: EnSafe/Allen & Hoshall

Date of Report: 05/07/96 Project No.: E-3-157

Client's Project No.: 0094-09000

Sample I.D.: 007SMW1548

Soil Description: Light Brown Silty Sand

Test Media: City of Memphis Water

	Pre-Test	Post Test
Wet Density (Lbs/ft^3)	129.6	134.4
Dry Density (Lbs/ft^3)	106.2	109.7
Moisture (% Dry Wt)	22.0	22.5
Porosity (n)	.346	.327
Degree of Saturation (%)	.97	1.0
Specific Gravity (ASTM D-854)	2.60	---

Permeability

Temperature Correction, $R_t = 1.002$

$K_1 = 2.1 \times 10^{-4}$ cm/sec
$K_2 = 2.4 \times 10^{-4}$ cm/sec
$K_3 = 2.0 \times 10^{-4}$ cm/sec
$K_4 = 1.9 \times 10^{-4}$ cm/sec

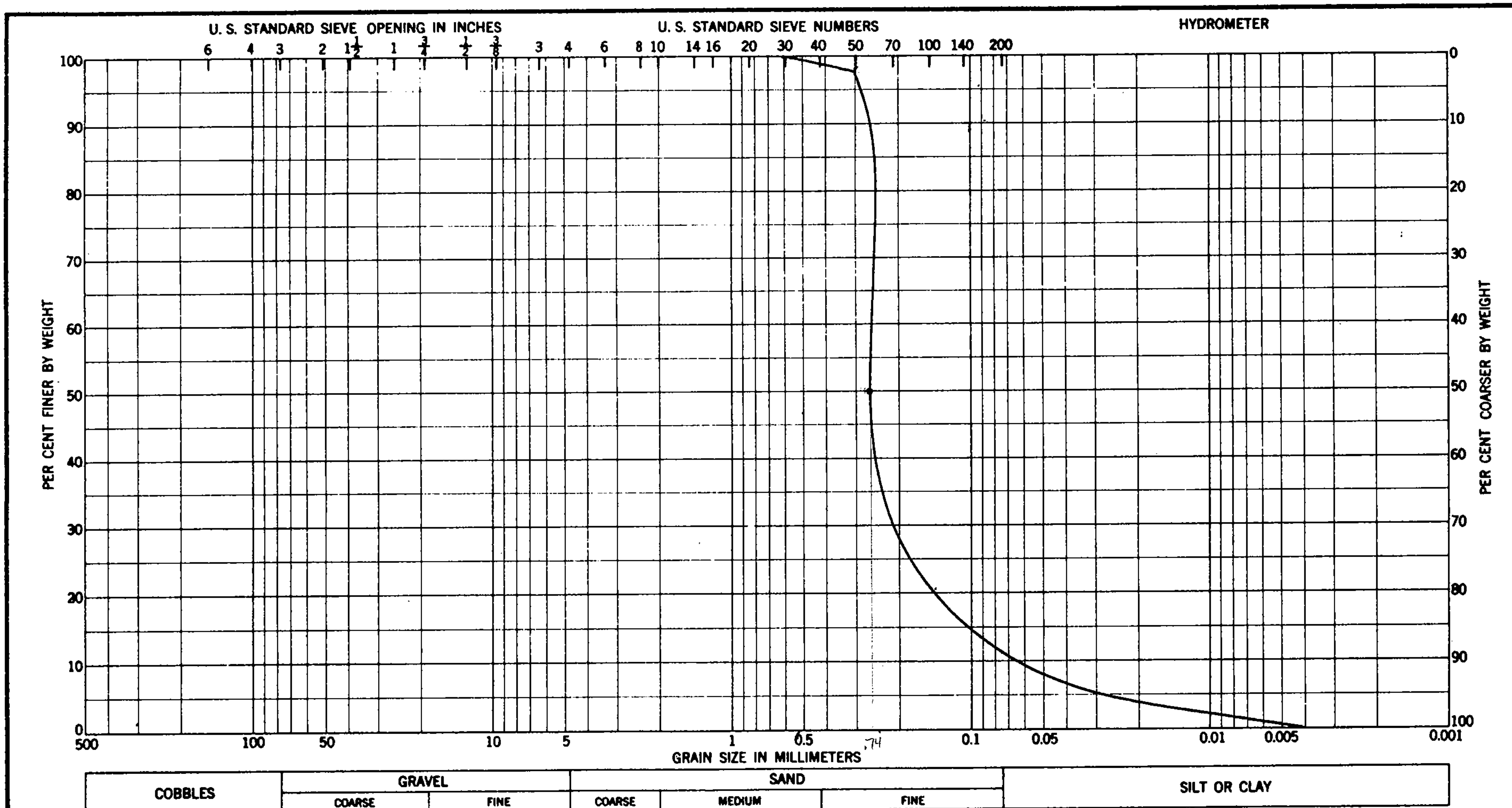
Coefficient of Permeability, $K_{20} = 2.1 \times 10^{-4}$ cm/sec

Tested in accordance with ASTM D-5084-90.

Lab No. P-96-030 Reviewed By: David D. McCray

David D. McCray

6756 BUCKLES COVE MEMPHIS, TN 38133 901-385-1199 FAX 901-386-6614



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
007SMW1548	--	SP-SM or SP-SC	22	--	--	--

Project EnSafe/A&H # 0094-09000

Area

Boring No.

Date 05/07/96

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.

TRI STATE
TESTING SERVICES, INC.

Measurement of Hydraulic Conductivity

Client: EnSafe/Allen & Hoshall

Date of Report: 05/22/96 Project No.: E-3-157

Client's Project No.: 0094-09000

Sample I.D.: 007SMW1849

Soil Description: Orange & Gray Silty Sand with Clay

Test Media: City of Memphis Water

	Pre-Test	Post Test
Wet Density (Lbs/ft^3)	126.3	133.7
Dry Density (Lbs/ft^3)	104.9	110.5
Moisture (% Dry Wt)	20.4	21.0
Porosity (n)	.38	.32
Degree of Saturation (%)	.91	1.00
Specific Gravity (ASTM D-854)	2.70	---

Permeability

Temperature Correction, $R_t = 1.008$

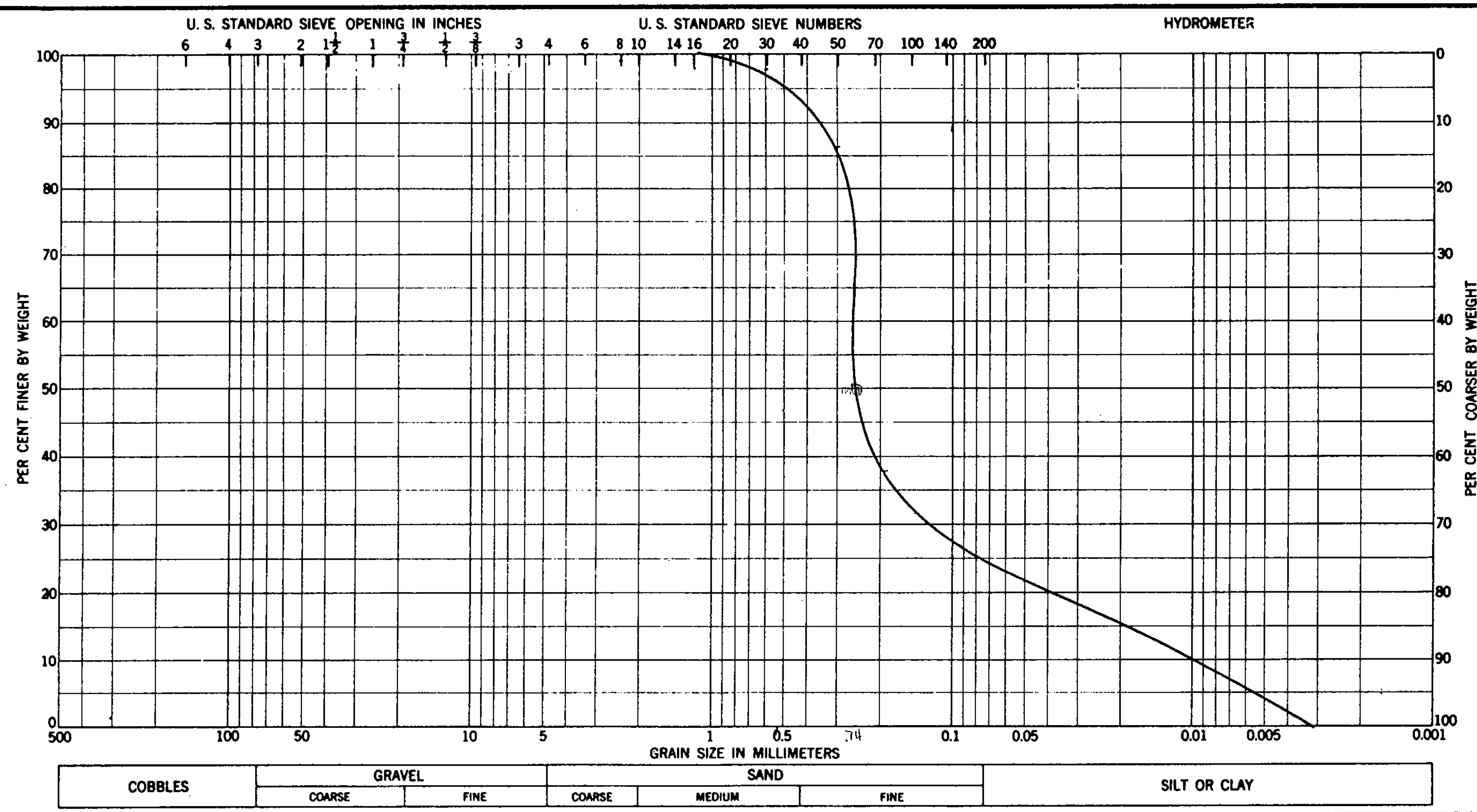
$K_1 = 1.4 \times 10^{-6}$ cm/sec
$K_2 = 1.6 \times 10^{-6}$ cm/sec
$K_3 = 1.5 \times 10^{-6}$ cm/sec
$K_4 = 1.5 \times 10^{-6}$ cm/sec

Coefficient of Permeability, $K_{20} = 1.5 \times 10^{-6}$ cm/sec

Tested in accordance with ASTM D-5084-90.

Lab No. P-96-031 Reviewed By: David D. McCray

6756 Buckles Cove Memphis, TN 38133 901-385-1199 FAX 901-386-6614



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
007SMW1849	46'-49'	SM or SC	20.4	--	--	--

Project EnSafe/A&H # 0094-09000

Area

Boring No.

Date 05/23/96

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.

TRI STATE
TESTING SERVICES, INC.

Measurement of Hydraulic Conductivity

Client: EnSafe/Allen & Hoshall

Date of Report: 05/06/96 Project No.: E-3-157

Client's Project No.: 0094-09000

Sample I.D.: 007SMW1749

Soil Description: Yellow Silty Sand

Test Media: City of Memphis Water

	Pre-Test	Post Test
Wet Density (Lbs/ft^3)	132.5	133.9
Dry Density (Lbs/ft^3)	108.5	109.1
Moisture (% Dry Wt)	22.1	22.7
Porosity (n)	.334	.337
Degree of Saturation (%)	.98	1.0
Specific Gravity (ASTM D-854)	2.61	---

Permeability

Temperature Correction, $R_t = 1.000$

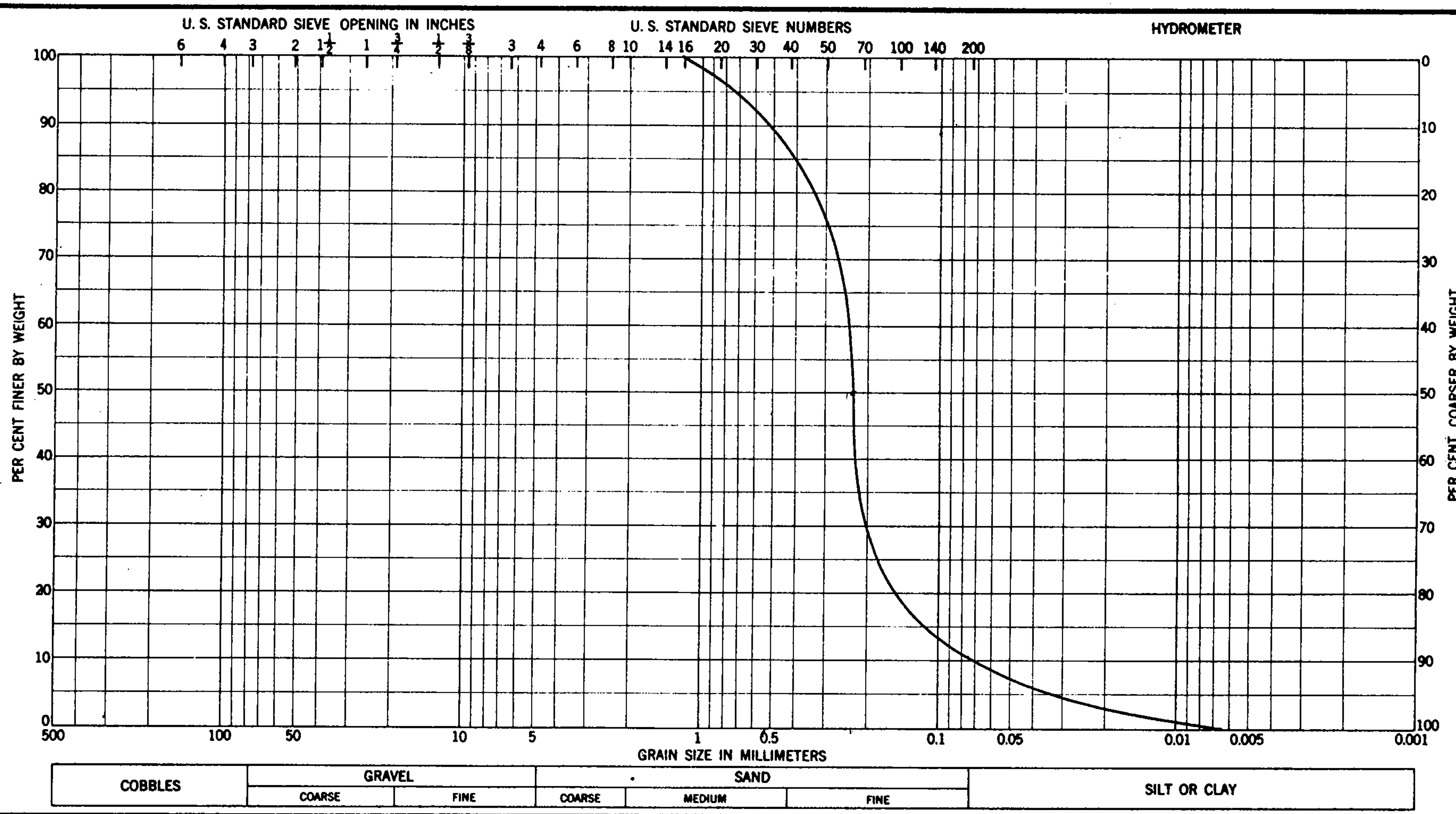
$K_1 = 2.2 \times 10^{-4}$ cm/sec
$K_2 = 2.2 \times 10^{-4}$ cm/sec
$K_3 = 2.1 \times 10^{-4}$ cm/sec
$K_4 = 2.4 \times 10^{-4}$ cm/sec

Coefficient of Permeability, $K_{20} = 2.2 \times 10^{-4}$ cm/sec

Tested in accordance with ASTM D-5084-90.

Lab No. P-96-023 Reviewed By: David D. McCray
David D. McCray

6756 BUCKLES COVE MEMPHIS, TN 38133 901-385-1199 FAX 901-386-6614



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
007SMW1749	--	SP - SM or SP - SC	22	--	--	--

Project EnSafe/A&H # 0094-09000

Area

Boring No.

Date 05/06/96

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.

TRI STATE
TESTING SERVICES, INC.

Measurement of Hydraulic Conductivity

Client: EnSafe/Allen & Hoshall

Date of Report: 05/31/96 Project No.: E-3-157

Client's Project No.: 0094-09000

Sample I.D.: 007SMW1643

Soil Description: Yellow Silty Sand

Test Media: City of Memphis Water

	Pre-Test	Post Test
Wet Density (Lbs/ft^3)	129.7	133.4
Dry Density (Lbs/ft^3)	113.0	114.3
Moisture (% Dry Wt)	14.8	16.7
Porosity (n)	.38	.36
Degree of Saturation (%)	.94	1.00
Specific Gravity (ASTM D-854)	2.63	---

Permeability

Temperature Correction, $R_t = 1.000$

$K_1 = 3.7 \times 10^{-5}$ cm/sec
$K_2 = 3.9 \times 10^{-5}$ cm/sec
$K_3 = 3.6 \times 10^{-5}$ cm/sec
$K_4 = 3.6 \times 10^{-5}$ cm/sec

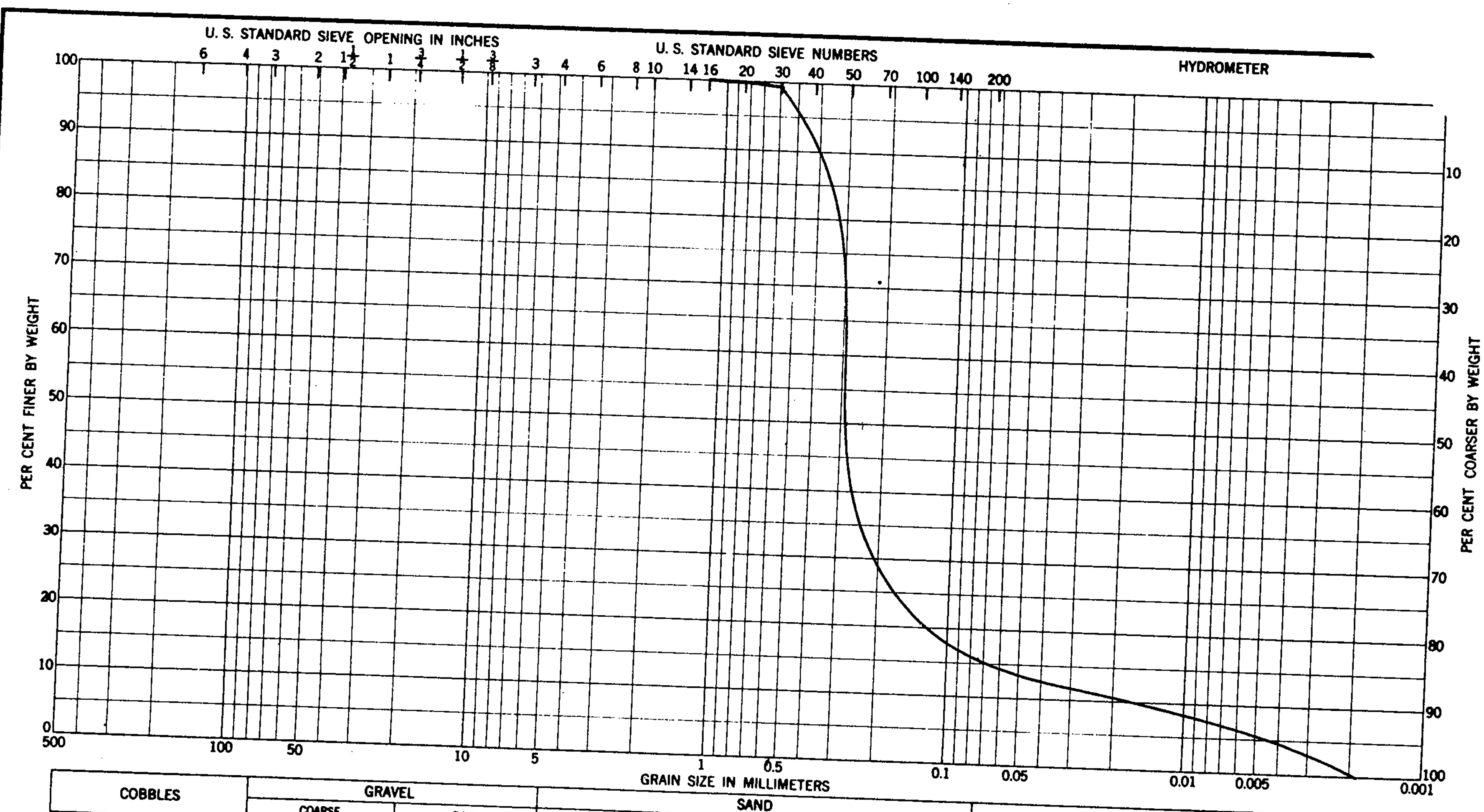
Coefficient of Permeability, $K_{20} = 3.7 \times 10^{-5}$ cm/sec

Tested in accordance with ASTM D-5084-90.

Lab No. P-96-022 Reviewed By: David D. McCray

David D. McCray

6756 Buckles Cove Memphis, TN 38133 901-385-1199 FAX 901-386-6614



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
007SMW1643		SM or SC	14.8	--	--	--

Project EnSafe/A&H # 0094-09000

Area

Boring No.

Date 05/31/96

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.

NAVY CLEAN
ENSAFE/ALLEN & HOSHALL
(901) 383-9115

CHAIN OF CUSTODY RECORD

PAGE 1 OF 1

CLIENT EnSafe
ADDRESS 5724 Summer Trees
PROJECT NAME/NUMBER 0094 09000
MEDIA STATUS: (A, B, OR C)

PROJECT MANAGER A. Choate
TELEPHONE NO. (901) 372-7962
FAX. NO. (901) 372-2454
SAMPLERS: (SIGNATURE) Alison Choate

FIELD SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	TYPE/SIZE OF CONTAINER	PRESERVATION TEMP.	PRESERVATION CHEMICAL	NO. OF CONTAINERS	Hydraulic Conductivity	Porosity	Bulk Density	Particle Size	Percent Moisture	Specific Gravity		REMARKS
007SMW1643	3/15/96	1355	soil	3" dia Shelby Tub	-	-	1	X	X	X	X	X	X		
007SMW1680	3/15/96	1510	soil	Plastic Bag	—	—	1			X	X	X			

RELINQUISHED BY:
SIGNATURE Alison Choate
PRINTED Alison Choate
COMPANY EnSafe
REASON Analysis
DATE
TIME

RECEIVED BY:
SIGNATURE
PRINTED
COMPANY
REASON
DATE
TIME

RELINQUISHED BY:
SIGNATURE
PRINTED
COMPANY
REASON
DATE
TIME

RECEIVED BY:
SIGNATURE
PRINTED
COMPANY
REASON
DATE
TIME

METHOD OF SHIPMENT: direct transport
SHIPMENT NO.
SPECIAL INSTRUCTION:

COMMENTS:

AFTER ANALYSIS, SAMPLES ARE TO BE:
- ☐ DISPOSED OF (ADDITIONAL FEE)
- ☐ STORED (90 DAYS MAX)
- ☐ STORED OVER 90 DAYS (ADDITIONAL FEE)
- ☐ RETURNED TO CUSTOMER

036CUST1

TRI STATE
TESTING SERVICES, INC.

Measurement of Hydraulic Conductivity

Client: EnSafe/Allen & Hoshall

Date of Report: 05/24/96 Project No.: E-3-157

Client's Project No.: 0094-09000

Sample I.D.: 007SMW1049

Soil Description: Clayey Silty Sand

Test Media: City of Memphis Water

	Pre-Test	Post Test
Wet Density (Lbs/ft^3)	134.5	134.9
Dry Density (Lbs/ft^3)	116.2	116.4
Moisture (% Dry Wt)	15.7	15.9
Porosity (n)	.31	.31
Degree of Saturation (%)	.95	1.00
Specific Gravity (ASTM D-854)	2.71	---

Permeability

Temperature Correction, $R_t = 1.007$

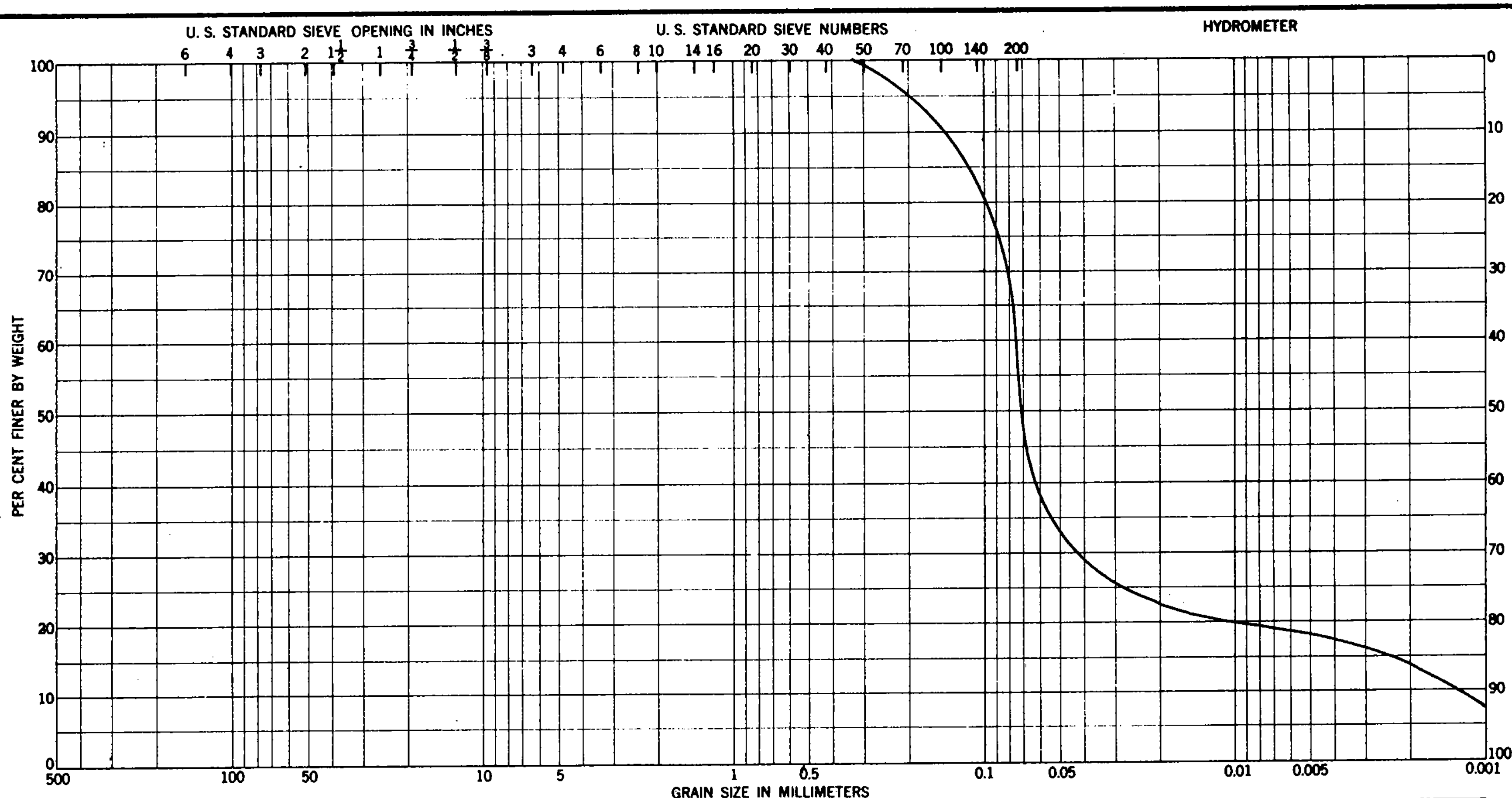
$K_1 = 3.1 \times 10^{-6}$ cm/sec
$K_2 = 3.3 \times 10^{-6}$ cm/sec
$K_3 = 3.5 \times 10^{-6}$ cm/sec
$K_4 = 3.3 \times 10^{-6}$ cm/sec

Coefficient of Permeability, $K_{20} = 3.3 \times 10^{-6}$ cm/sec

Tested in accordance with ASTM D-5084-90.

Lab No. P-96-026 Reviewed By: David D. McCray
David D. McCray

6756 BUCKLES COVE MEMPHIS, TN 38133 901-385-1199 FAX 901-386-6614



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
007SMW1349	46-49'	ML, CL, OL, MH, CH or OH	15.7	--	--	--

Project EnSafe/A&H # 0094-09000

Area

Boring No.

Date 05/24/96

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.

TRI STATE
TESTING SERVICES, INC.

Measurement of Hydraulic Conductivity

Client: EnSafe/Allen & Hoshall

Date of Report: 05/23/96 Project No.: E-3-157

Client's Project No.: 0094-09000

Sample I.D.: 007SMW1149

Soil Description: Orange Sand

Test Media: City of Memphis Water

	Pre-Test	Post Test
Wet Density (Lbs/ft^3)	140.9	141.0
Dry Density (Lbs/ft^3)	129.4	128.1
Moisture (% Dry Wt)	8.6	10.1
Porosity (n)	.26	.27
Degree of Saturation (%)	.69	.99
Specific Gravity (ASTM D-854)	2.81	---

Permeability

Temperature Correction, $R_t = 0.901$

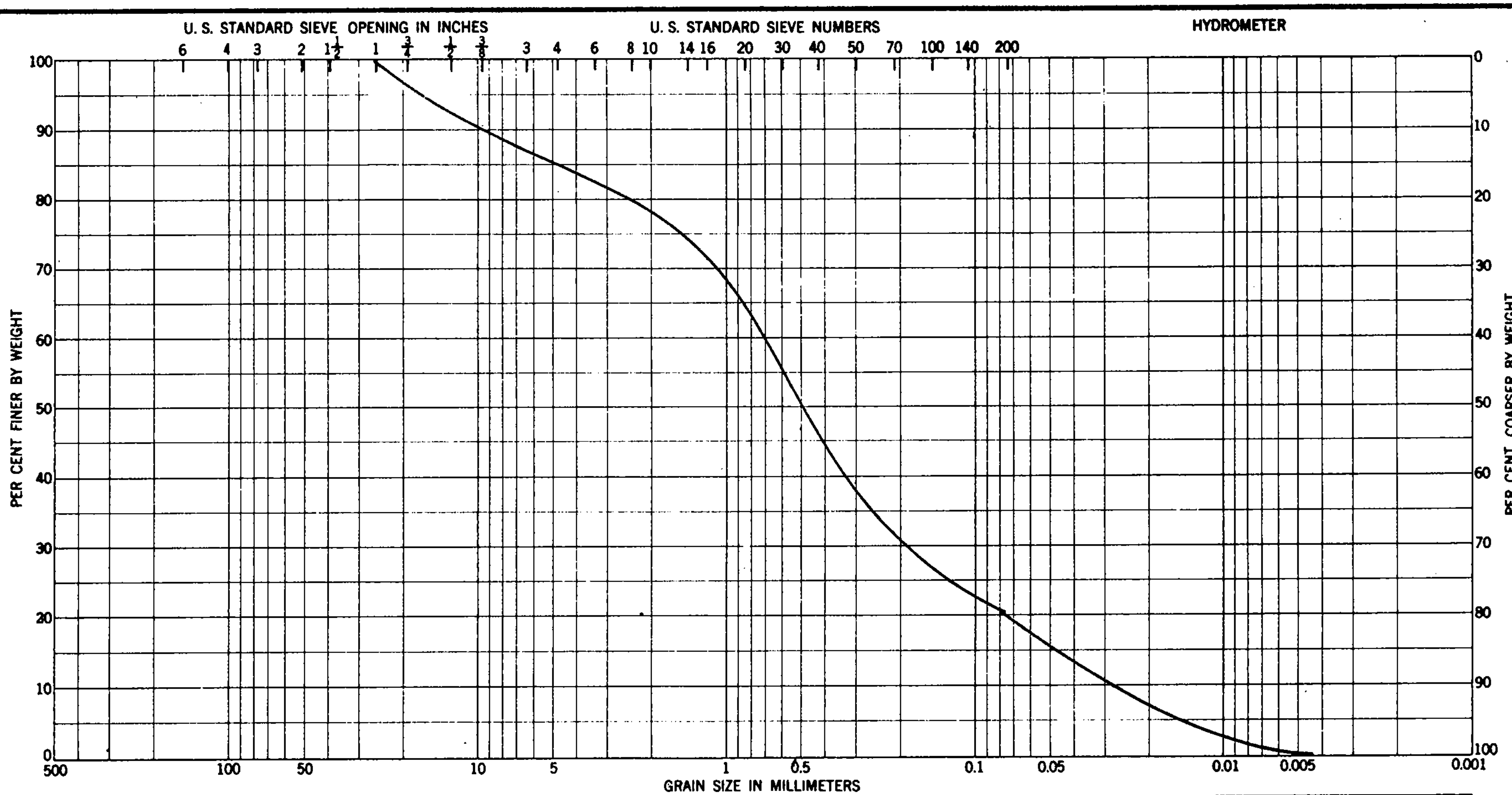
$K_1 = 9.2 \times 10^{-5}$ cm/sec
$K_2 = 8.4 \times 10^{-5}$ cm/sec
$K_3 = 9.7 \times 10^{-5}$ cm/sec
$K_4 = 9.4 \times 10^{-5}$ cm/sec

Coefficient of Permeability, $K_{20} = 8.3 \times 10^{-5}$ cm/sec

Tested in accordance with ASTM D-5084-90.

Lab No. P-96-027 Reviewed By: David D. McCray
David D. McCray

6756 Buckles Cove Memphis, TN 38133 901-385-1199 FAX 901-386-6614



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
007SMW1149	46'-49'	SM or SC	8.6	--	--	--

Project	EnSafe/A&H # 00094-09000
Area	
Boring No.	05/22/96
Date	

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.

TRI STATE
TESTING SERVICES, INC.

Measurement of Hydraulic Conductivity

Client: EnSafe/Allen & Hoshall

Date of Report: 05/23/96 Project No.: E-3-157

Client's Project No.: 0094-09000

Sample I.D.: 007SMW1243

Soil Description: Orange Silty Sand with trace of Clay

Test Media: City of Memphis Water

	Pre-Test	Post Test
Wet Density (Lbs/ft^3)	127.5	132.9
Dry Density (Lbs/ft^3)	107.0	110.4
Moisture (% Dry Wt)	19.2	20.4
Porosity (n)	.36	.35
Degree of Saturation (%)	.92	1.00
Specific Gravity (ASTM D-854)	2.72	---

Permeability

Temperature Correction, $R_t = 1.006$

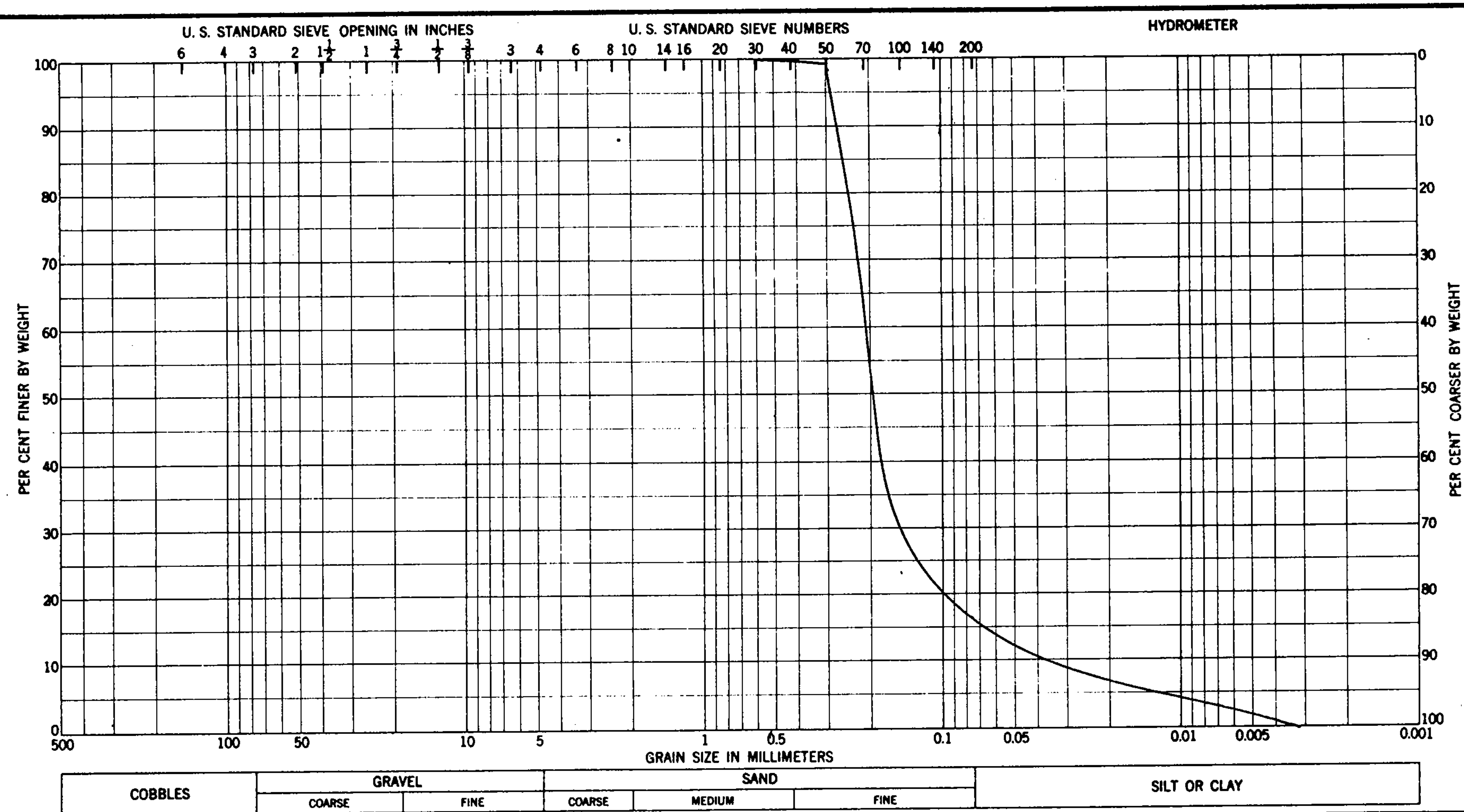
$K_1 = 2.3 \times 10^{-5}$ cm/sec
$K_2 = 2.8 \times 10^{-5}$ cm/sec
$K_3 = 2.0 \times 10^{-5}$ cm/sec
$K_4 = 2.9 \times 10^{-5}$ cm/sec

Coefficient of Permeability, $K_{20} = 2.5 \times 10^{-5}$ cm/sec

Tested in accordance with ASTM D-5084-90.

Lab No. P-96-028 Reviewed By: D. D. McCray
David D. McCray

6756 Buckles Cove Memphis, TN 38133 901-385-1199 FAX 901-386-6614



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
007SMW1243	40'-43'	Sm or Sc	19.2	--	--	--

Project EnSafe/A&H # 0094-09000

Area

Boring No.

Date 05/23/96

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.

TRI STATE
TESTING SERVICES, INC.

Measurement of Hydraulic Conductivity

Client: EnSafe/Allen & Hoshall

Date of Report: 05/24/96 Project No.: E-3-157

Client's Project No.: 0094-09000

Sample I.D.: 007SMW1349

Soil Description: Light Gray Clayey Silty with Fine Sand

Test Media: City of Memphis Water

	Pre-Test	Post Test
Wet Density (Lbs/ft^3)	129.9	137.6
Dry Density (Lbs/ft^3)	109.0	115.2
Moisture (% Dry Wt)	19.2	19.4
Porosity (n)	.34	.31
Degree of Saturation (%)	.98	1.00
Specific Gravity (ASTM D-854)	2.68	---

Permeability

Temperature Correction, $R_t = 1.001$

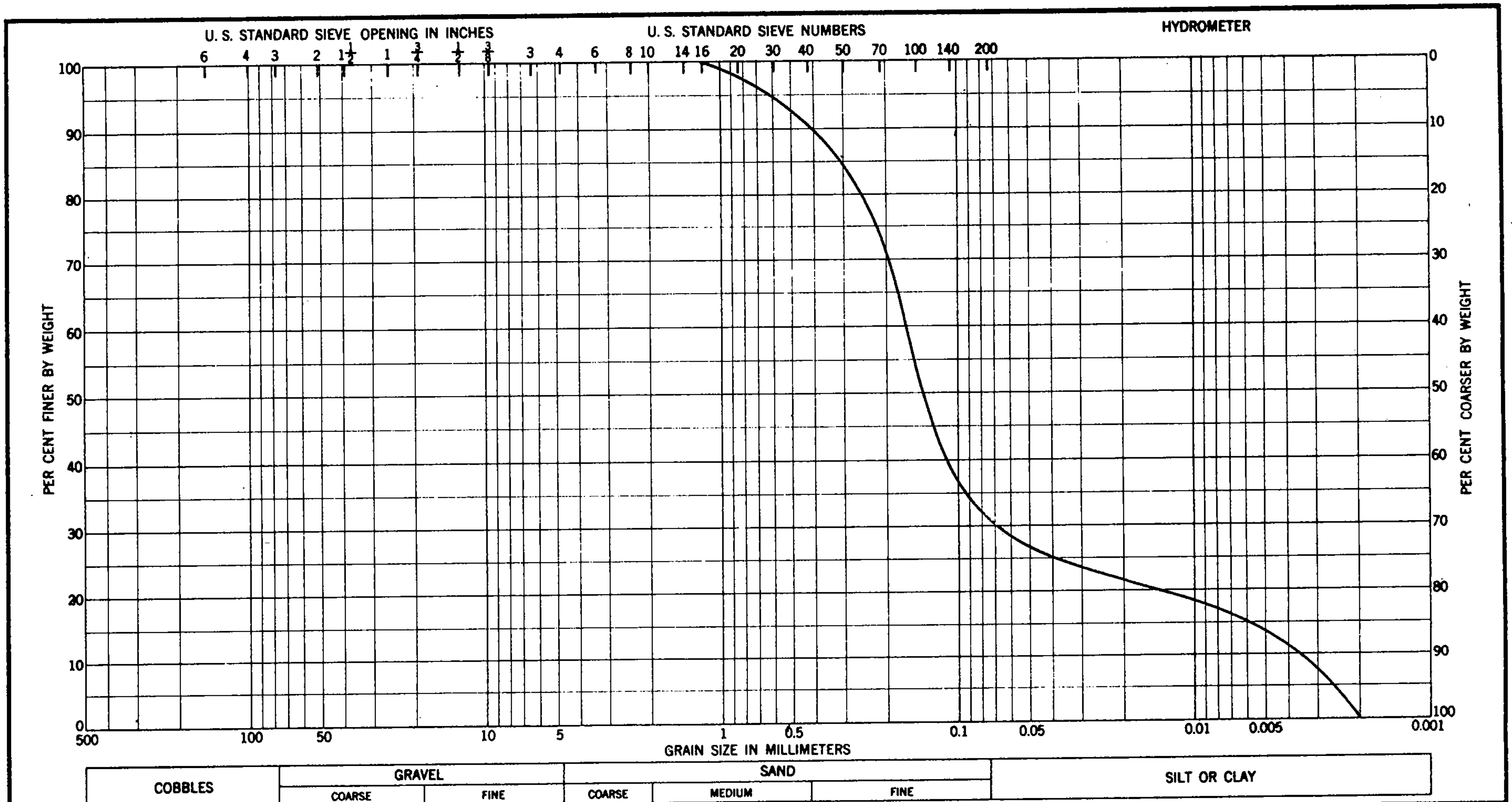
$K_1 = 8.2 \times 10^{-7}$ cm/sec
$K_2 = 1.3 \times 10^{-6}$ cm/sec
$K_3 = 1.2 \times 10^{-6}$ cm/sec
$K_4 = 9.8 \times 10^{-7}$ cm/sec

Coefficient of Permeability, $K_{20} = 1.1 \times 10^{-6}$ cm/sec

Tested in accordance with ASTM D-5084-90.

Lab No. P-96-029 Reviewed By: David D. McCray
David D. McCray

6756 Buckles Cove Memphis, TN 38133 901-385-1199 FAX 901-386-6614



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
007SMW1049	46-49'	SM or SC	19.2	--	--	--

Project EnSafe/A&H # 0094-09000

Area

Boring No.

Date 05/24/96

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.

NAVY CLEAN
ENSAFE/ALLEN & HOSHALL
(901) 383-9115

CHAIN OF CUSTODY RECORD

PAGE 1 OF 1

CLIENT: EnSafe
ADDRESS: 5724 Summer Trees Dr. Memphis
PROJECT NAME/NUMBER: 0094-09000
MEDIA STATUS: (A, B, OR C)
PROJECT MANAGER: Alison Choate
TELEPHONE NO.: 901 372 7962
FAX. NO.: 901 372 2454
SAMPLERS: (SIGNATURE) A. Choate

	FIELD SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	TYPE/SIZE OF CONTAINER	PRESERVATION TEMP.	PRESERVATION CHEMICAL	NO. OF CONTAINERS	Hydraulic Conductivity	Porosity	Bulk Density	Particle Size	Percent Moisture	Specific Gravity			REMARKS
X	007SMW1049	3/15/96	0815	Soil	3" dia Shelby Tub	–	–	1	X	X	X	X	X	X			
X	007SMW1149	3/18/96	1250	Soil	3" dia Shelby	–	–	1	X	X	X	X	X	X			
X	007SMW1243	3/16/96	0900	Soil	3" dia Shelby	–	–	1	X	X	X	X	X	X			
X	007SMW1349	3/17/96	1500	Soil	3" dia Shelby	–	–	1	X	X	X	X	X	X			
X	007SMW1168	3/18/96	1330	Soil	Plastic bag	–	–	1				X	X	X			
X	007SMW1368	3/16/96	1530	Soil	Plastic bag	–	–	1				X	X	X			
X	007SMW1290	3/16/96	1015	Soil	Plastic bag	–	–	1				X	X	X			
X	007SMW1440	3/16/96	1415	Soil	Plastic bag	–	–	1				X	X	X			
X	007SMW1072	3/18/96	0900	Soil	Plastic bag	–	–	1				X	X	X			

RELINQUISHED BY:	DATE / TIME	RELINQUISHED BY:	DATE / TIME	RELINQUISHED BY:	DATE / TIME	RELINQUISHED BY:	DATE / TIME
SIGNATURE: Charles Ivey	DATE: 3/18/96	SIGNATURE: Andy Jacobs	DATE:	SIGNATURE:	DATE:	SIGNATURE:	DATE:
PRINTED: Charles Ivey	TIME: 1715	PRINTED: Andy Jacobs	TIME:	PRINTED:	TIME:	PRINTED:	TIME:
COMPANY: EnSafe		COMPANY: TSTS		COMPANY:		COMPANY:	
REASON: analysis		REASON: Testing		REASON:		REASON:	

METHOD OF SHIPMENT: direct transport
SHIPMENT NO.
SPECIAL INSTRUCTION:

COMMENTS:

AFTER ANALYSIS, SAMPLES ARE TO BE:
- ☐ DISPOSED OF (ADDITIONAL FEE)
- ☐ STORED (90 DAYS MAX)
- ☐ STORED OVER 90 DAYS (ADDITIONAL FEE)
- ☐ RETURNED TO CUSTOMER

TRI STATE
TESTING SERVICES, INC.

REPORT OF SPECIFIC GRAVITY

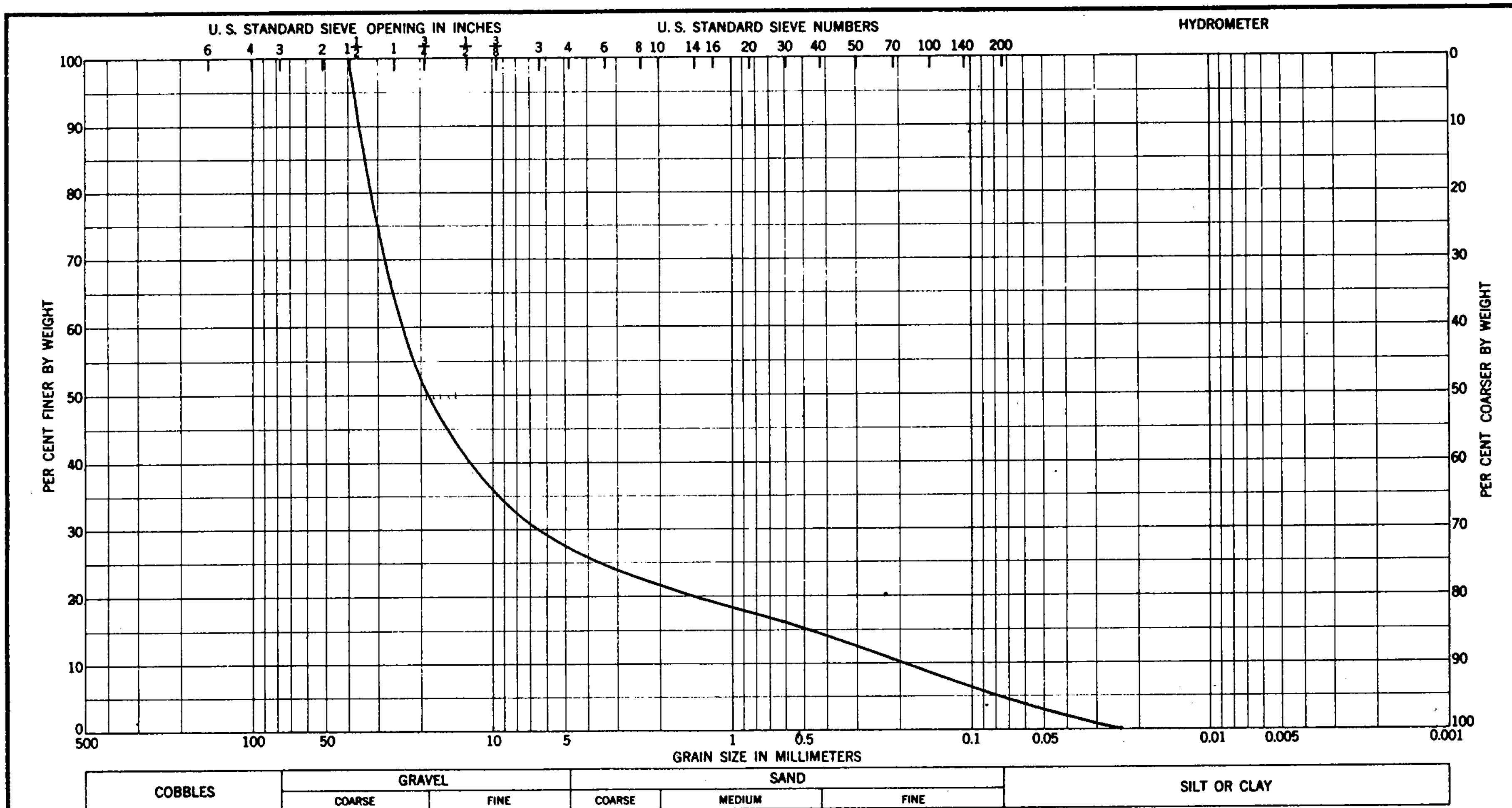
Prepared for: EnSafe/Allen & Hoshall
EnSafe/A&H Project No.: 0094-09000

Job No.: E-3-157
Sheet 1 of 1
Date: 30 April '96

SAMPLE I.D.	SPECIFIC GRAVITY
007SMW1772	2.70
007SMW1680	2.61
007SMW1168	2.69
007SMW1368	2.68
007SMW1290	2.69
007SMW1440	2.65
007SMW1072	2.71
007SMW1896	2.69
007SMW15100	2.68

Tested in accordance with ASTM D-854.

Reviewed By: D. D. McCray
David D. McCray



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
007SMW1072	70-72'	GP	6	--	--	--

Project EnSafe/A&H # 0094-09000

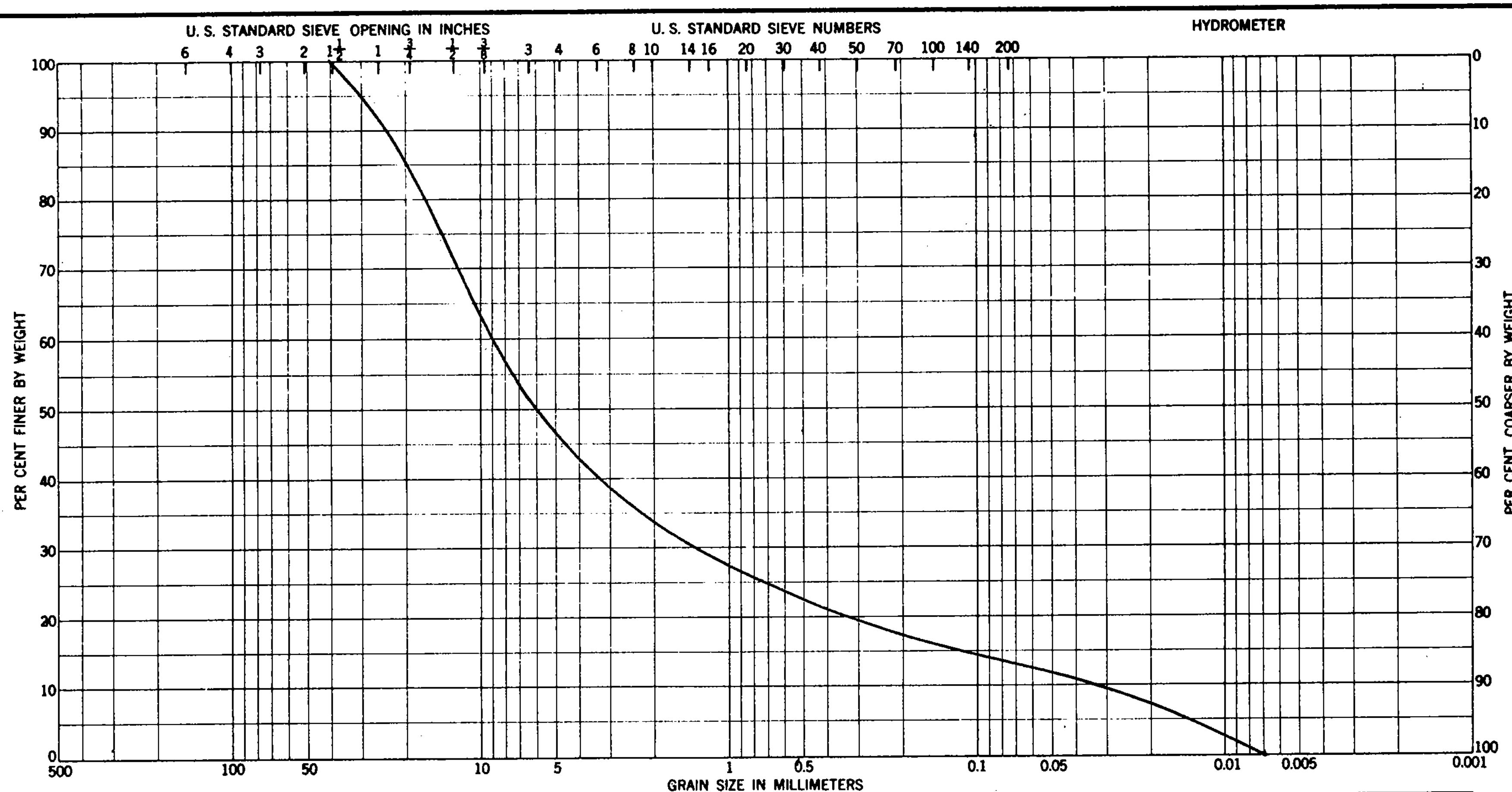
Area

Boring No.

Date 03/29/96

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
007SMW1680	78-80'	GM or GC	6.5	--	--	--

Project EnSafe/A&H # 0094-09000

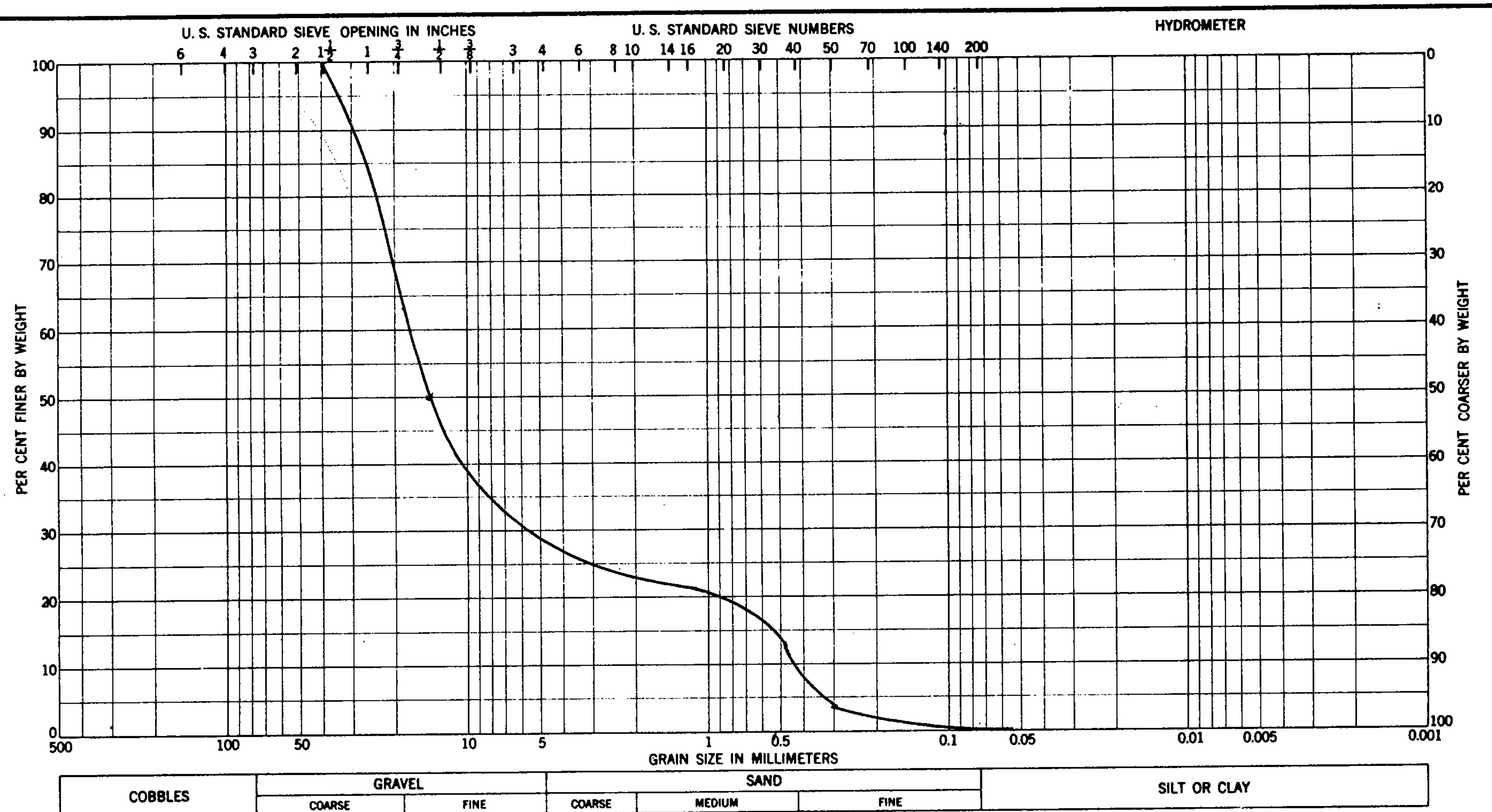
Area

Boring No.

Date 03/29/96

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
007SMW1772	70-72'	GP	6.4	--	--	--

Project EnSafe/A&H # 0094-09000

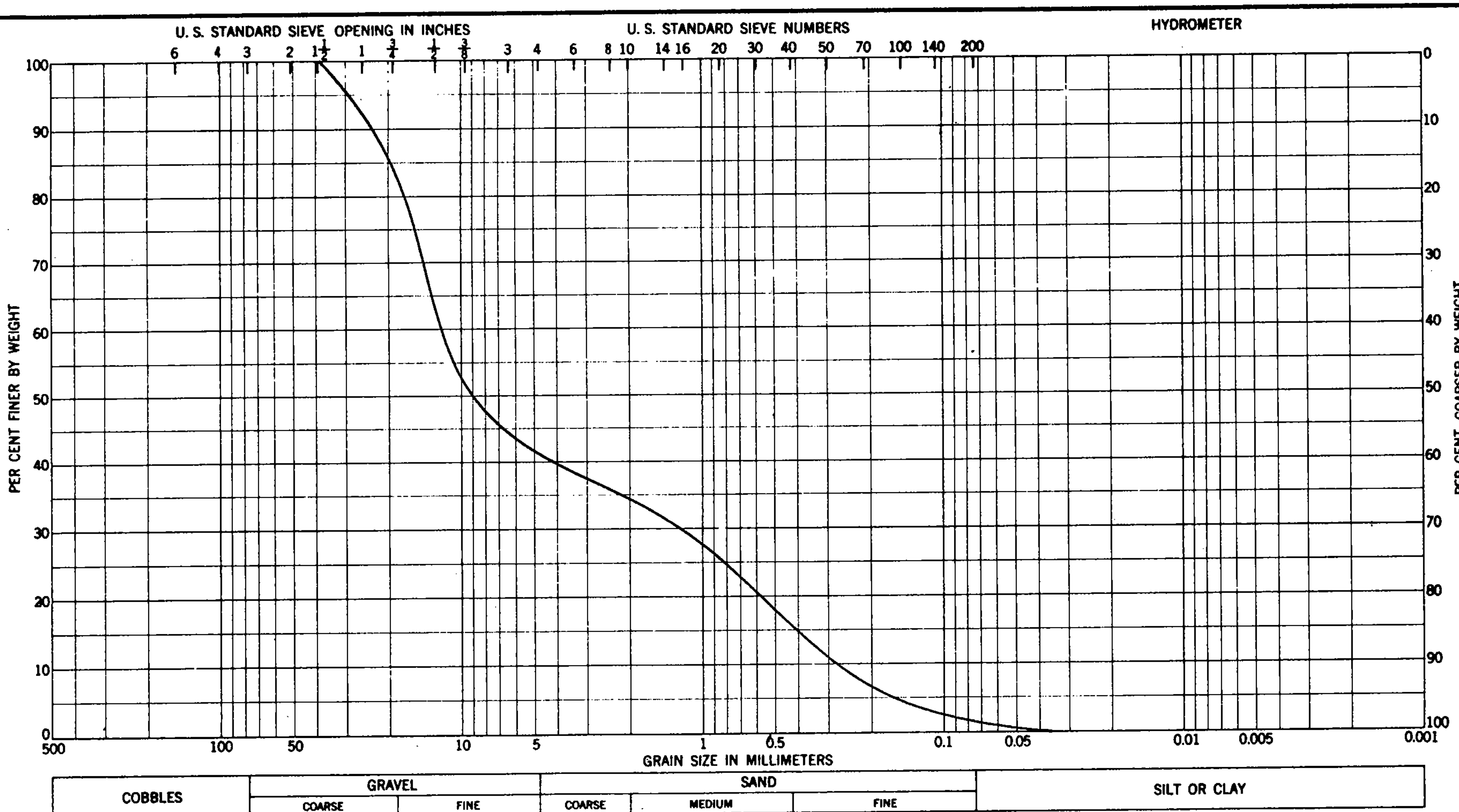
Area

Boring No.

Date 03/29/96

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
007SMW1168	66-68'	GP	8	--	--	--

Project EnSafe/A&H # 0094-09000

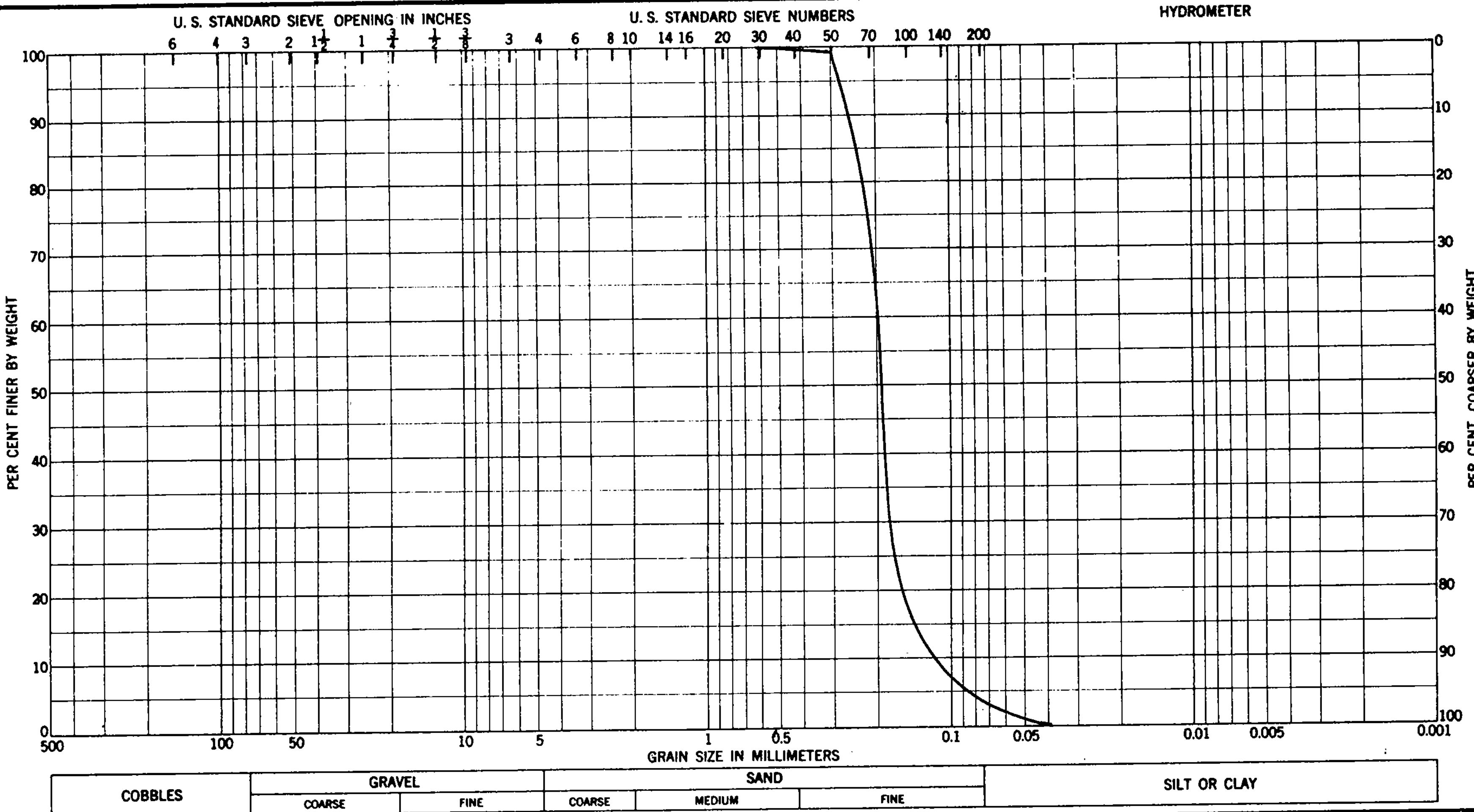
Area

Boring No.

Date 03/29/96

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
007SMW1368	66-68'	SP	25	--	--	--

Project EnSafe/A&H 0094-09000

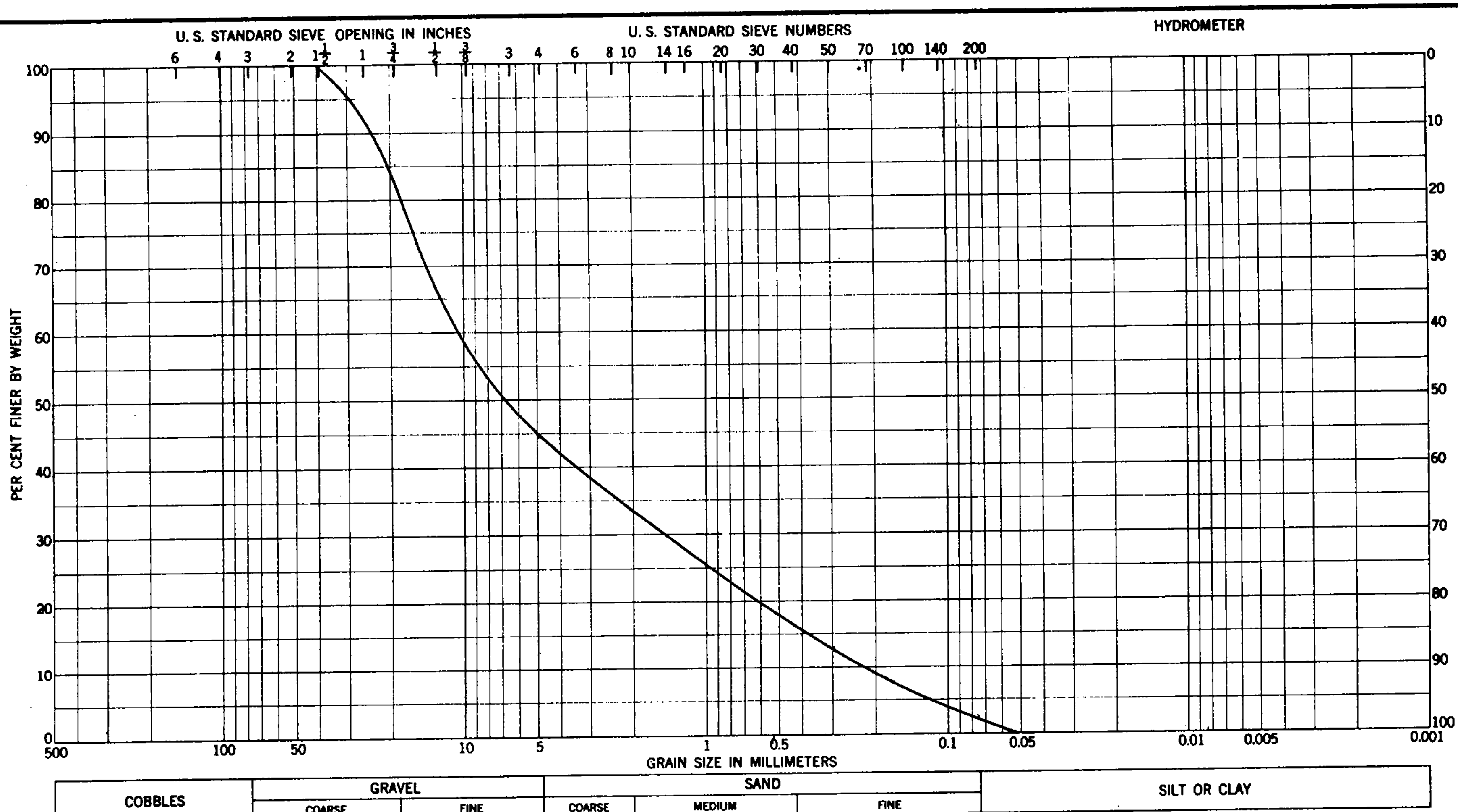
Area

Boring No.

Date 03/29/96

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
008SMW1290	88-90'	GW	9	--	--	--

Project EnSafe/A&H # 0094-09000

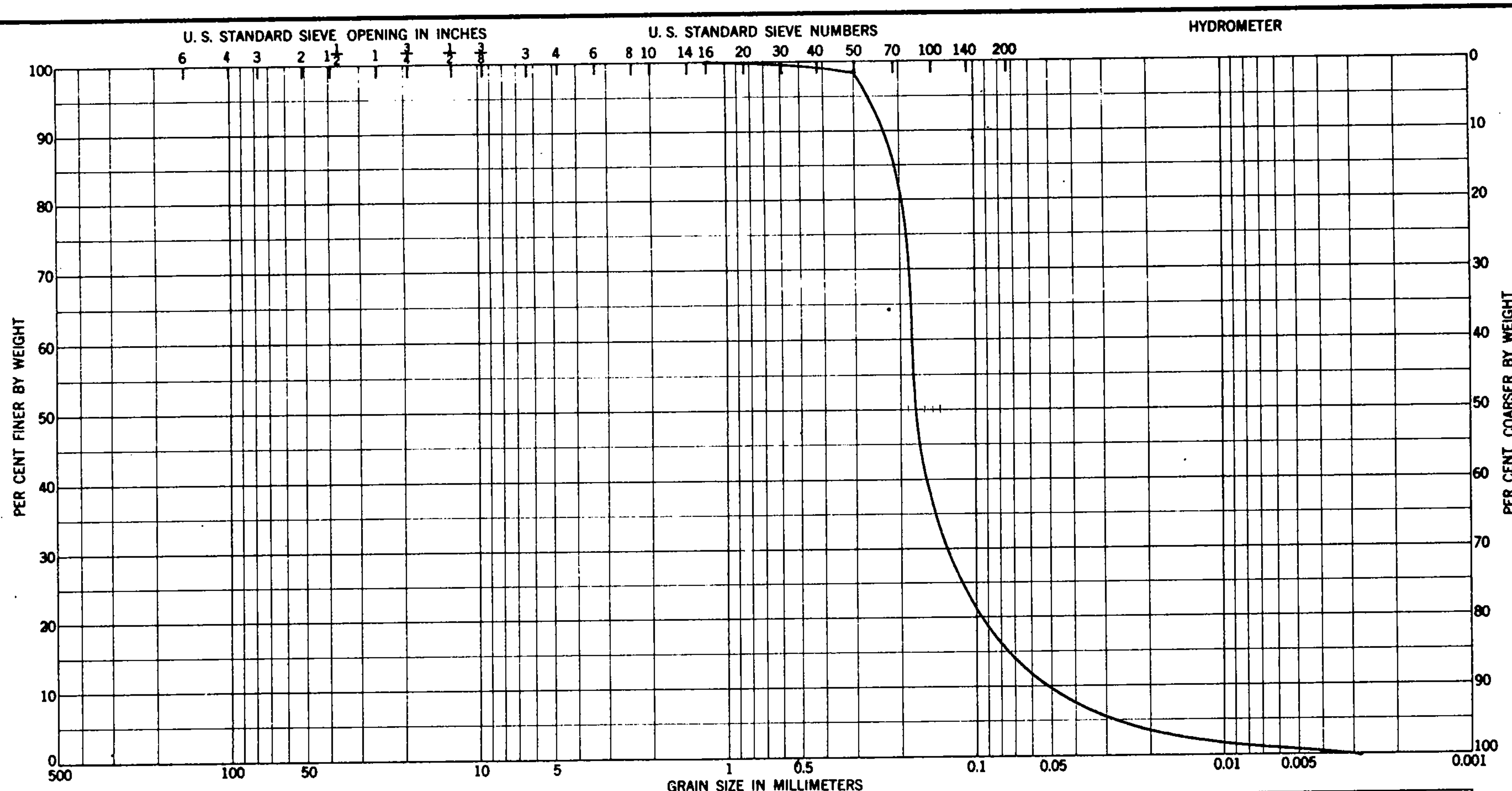
Area

Boring No.

Date 03/29/96

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
007SMW1440	38-40'	SM or SC	10	--	--	--

Project EnSafe/A&H # 0094-09000

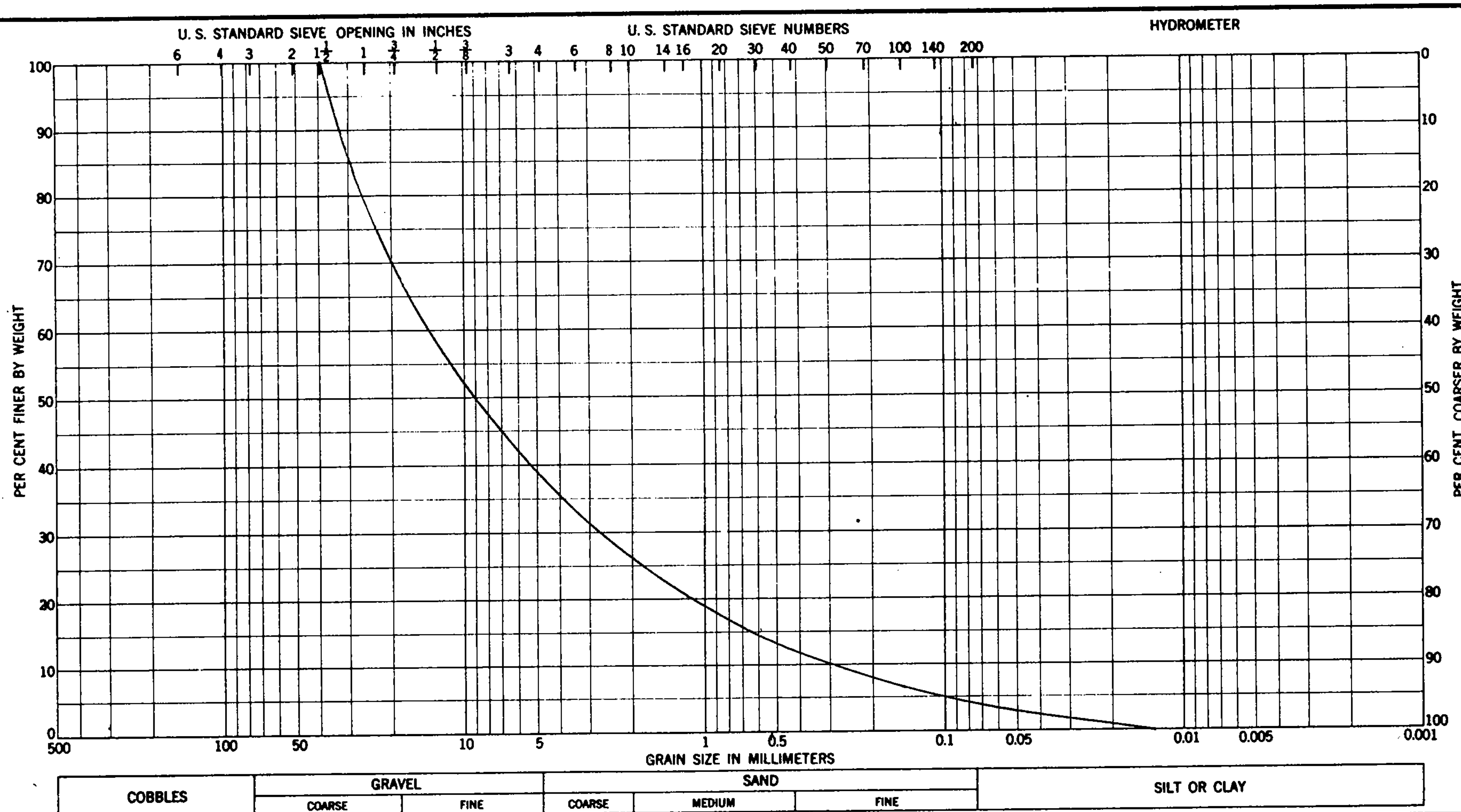
Area

Boring No.

Date 03/29/96

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
007SMW1896		GP	11	--	--	--

Project EnSafe/A&H # 0094-09000

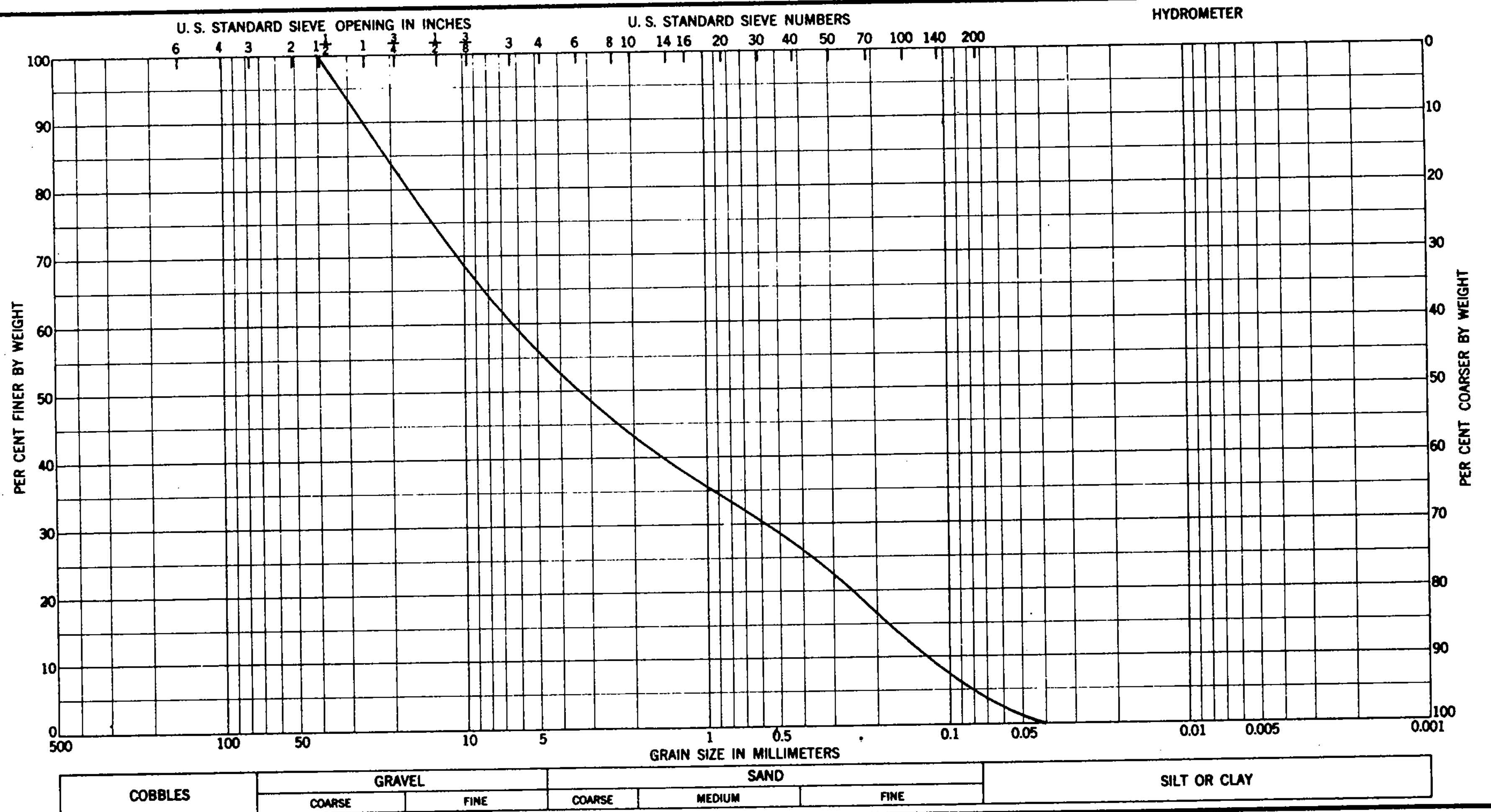
Area

Boring No.

Date 04/29/96

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
007SMW15100		SP	04	--	--	--

Project EnSafe/A&H # 0094-09000

Area

Boring No.

Date 04/29/96

GRADATION CURVES

TRI-STATE TESTING SERVICES, INC.

COPY

NAVY CLEAN

ENSAFE/ALLEN & HOSHALL
(901) 383-9115

CHAIN OF CUSTODY RECORD

PAGE 1 OF 1

CLIENT: EnSafe
ADDRESS: 5724 Summer Trees Dr
PROJECT NAME/NUMBER: C094-09000
MEDIA STATUS: (A, B, OR C) ______

PROJECT MANAGER: Alison Choate
TELEPHONE NO.: 3722454
FAX. NO.: 3727962
SAMPLERS: (SIGNATURE) A. Choate

	FIELD SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	TYPE/SIZE OF CONTAINER	PRESERVATION TEMP.	PRESERVATION CHEMICAL	NO. OF CONTAINERS	Hydraulic Conductivity	Porosity	Bulk Density	Particle Size	Percent Moisture	Specific Gravity		REMARKS
	007SMW17 49	3/15/96	0855	soil	3" dia Shelby	–	–	1	X	X	X	X	X	X		
x	007SMW17 72	3/15/96	0947	soil	Plastic Bag	–	–	1			X	X	X			

RELINQUISHED BY:	DATE / TIME	RELINQUISHED BY:	DATE / TIME	RELINQUISHED BY:	DATE / TIME	RELINQUISHED BY:	DATE / TIME
SIGNATURE: Alison Choate	DATE: 3/15/96	SIGNATURE: Charles Ivey	DATE: 96 3/15	SIGNATURE:	DATE:	SIGNATURE:	DATE:
PRINTED: Alison Choate		PRINTED: Charles Ivey		PRINTED:		PRINTED:	
COMPANY: EnSafe	TIME: 1030	COMPANY: ENSAFE	TIME: 1137	COMPANY:	TIME:	COMPANY:	TIME:
REASON: analysis		REASON: Analysis Deliver		REASON:		REASON:	

METHOD OF SHIPMENT: direct transport
SHIPMENT NO.: ______
SPECIAL INSTRUCTION: ______

COMMENTS: ______

AFTER ANALYSIS, SAMPLES ARE TO BE:
- ☐ DISPOSED OF (ADDITIONAL FEE)
- ☐ STORED (90 DAYS MAX)
- ☐ STORED OVER 90 DAYS (ADDITIONAL FEE)
- ☐ RETURNED TO CUSTOMER

NAVY CLEAN
ENSAFE/ALLEN & HOSHALL
(901) 383-9115

CHAIN OF CUSTODY RECORD

PAGE 1 OF 1

CLIENT EnSafe
ADDRESS 5724 Summer Trees
PROJECT NAME/NUMBER 0094 09000
MEDIA STATUS: (A, B, OR C)

PROJECT MANAGER A. Choate
TELEPHONE NO. (901) 372-7962
FAX. NO. (901) 372-2454
SAMPLERS: (SIGNATURE) Alison Choate

FIELD SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	TYPE/SIZE OF CONTAINER	PRESERVATION TEMP.	PRESERVATION CHEMICAL	NO. OF CONTAINERS	Hydraulic Conductivity	Porosity	Bulk Density	Particle Size	Percent Mx	Specific Gravity		REMARKS
007SMW1643	3/15/96	1355	soil	3" dia Shelby Tub	–	–	1	X	X	X	X	X	X		
007SMW1680	3/15/96	1510	soil	Plastic Bag	–	–	1				X	X	X		

RELINQUISHED BY:	DATE / TIME	RECEIVED BY:	DATE / TIME	RELINQUISHED BY:	DATE / TIME	RECEIVED BY:	DATE / TIME
SIGNATURE Alison Choate		SIGNATURE		SIGNATURE		SIGNATURE	
PRINTED Alison Choate		PRINTED		PRINTED		PRINTED	
COMPANY EnSafe		COMPANY		COMPANY		COMPANY	
REASON Analysis		REASON		REASON		REASON	

METHOD OF SHIPMENT: direct transfer
SHIPMENT NO.
SPECIAL INSTRUCTION:

COMMENTS:

AFTER ANALYSIS, SAMPLES ARE TO BE:
- ☐ DISPOSED OF (ADDITIONAL FEE)
- ☐ STORED (90 DAYS MAX)
- ☐ STORED OVER 90 DAYS (ADDITIONAL FEE)
- ☐ RETURNED TO CUSTOMER

COPY

036CUST1

COPY

NAVY CLEAN
ENSAFE/ALLEN & HOSHALL
(901) 383-9115

CHAIN OF CUSTODY RECORD

PAGE 1 OF 1

CLIENT: EnSafe
ADDRESS: 5724 Summer Trees Dr. Memphis
PROJECT NAME/NUMBER: 0094-09000
MEDIA STATUS: (A, B, OR C) ___

PROJECT MANAGER: Alison Choate
TELEPHONE NO.: 901 372 7962
FAX NO.: 901 372 2454
SAMPLERS: (SIGNATURE) A. Choate

	FIELD SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	TYPE/SIZE OF CONTAINER	PRESERVATION TEMP.	PRESERVATION CHEMICAL	NO. OF CONTAINERS	Hydraulic Conductivity	Porosity	Bulk Density	Particle Size	Percent Moist	Specific Gravity		REMARKS
	007SMW1049	3/18/96	0815	Soil	3" dia Shelby Tub	—	—	1	X	X	X	X	X	X		
	007SMW1149	3/18/96	1250	Soil	3" dia Shelby	—	—	1	X	X	X	X	X	X		
	007SMW1243	3/16/96	0900	Soil	3" dia Shelby	—	—	1	X	X	X	X	X	X		
	007SMW1349	3/17/96	1500	Soil	3" dia Shelby	—	—	1	X	X	X	X	X	X		
x	007SMW1168	3/18/96	1330	Soil	Plastic bag	—	—	1				X	X	X		
x	007SMW1368	3/16/96	1530	Soil	Plastic bag	—	—	1				X	X	X		
x	007SMW1290	3/16/96	1015	Soil	Plastic bag	—	—	1				X	X	X		
x	007SMW1440	3/16/96	1415	Soil	Plastic bag	—	—	1				X	X	X		
x	007SMW1072	3/18/96	0900	Soil	Plastic bag	—	—	1				X	X	X		

RELINQUISHED BY:	DATE / TIME	RELINQUISHED BY:	DATE / TIME	RELINQUISHED BY:	DATE / TIME	RELINQUISHED BY:	DATE / TIME
SIGNATURE: Charles Ivey	DATE: 3/18/96	SIGNATURE: Andy Jacobs	DATE:	SIGNATURE:	DATE:	SIGNATURE:	DATE:
PRINTED: Charles Ivey		PRINTED: Andy Jacobs		PRINTED:		PRINTED:	
COMPANY: EnSafe	TIME: 1715	COMPANY: TSTS	TIME:	COMPANY:	TIME:	COMPANY:	TIME:
REASON: analysis		REASON: Testing		REASON:		REASON:	

METHOD OF SHIPMENT: direct transport
SHIPMENT NO.
SPECIAL INSTRUCTION:

COMMENTS:

AFTER ANALYSIS, SAMPLES ARE TO BE:
- ☐ DISPOSED OF (ADDITIONAL FEE)
- ☐ STORED (90 DAYS MAX)
- ☐ STORED OVER 90 DAYS (ADDITIONAL FEE)
- ☐ RETURNED TO CUSTOMER

COPY

NAVY CLEAN
ENSAFE/ALLEN & HOSHALL
(901) 383-9115

CHAIN OF CUSTODY RECORD

PAGE 1 OF 1

CLIENT EnSafe
ADDRESS 5724 Summer Trees Dr
PROJECT NAME/NUMBER 0094-09000
MEDIA STATUS: (A, B, OR C) ______

PROJECT MANAGER A. Choate
TELEPHONE NO. 9013727962
FAX. NO. 9013722454
SAMPLERS: (SIGNATURE) A. Choate

	FIELD SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	TYPE/SIZE OF CONTAINER	PRESERVATION TEMP.	PRESERVATION CHEMICAL	NO. OF CONTAINERS	Hydraulic Conduct.	Porosity	Bulk Density	Particle Size	Percent Moisture	Specific Gravity		REMARKS
	007SMW1849	3/19/96	0815	soil	3" dia Shelby Tube	—	—	1	X	X	X	X	X	X		
X	007SMW1896	3/19/96	1000	soil	Plastic Bag	—	—	1				X	X	X		
X	007SMW15100	3/19/96	1430	soil	Plastic Bag	—	—	1				X	X	X		
	007SMWI548	3/19/96	1350	soil	3" dia. Shelby	—	—	1	X	X	X	X	X	X		Note. Only 12" recov"
	007SMWI548A	3/19/96	1650	"	Plasticbag	—	—	1				X	X	X		So we also took a plastic bag. (Same sample interval) See comments

analyze only if you need it

RELINQUISHED BY:	DATE / TIME	RELINQUISHED BY:	DATE / TIME	RELINQUISHED BY:	DATE / TIME	RELINQUISHED BY:	DATE / TIME
SIGNATURE ______		SIGNATURE ______		SIGNATURE ______		SIGNATURE ______	
PRINTED ______		PRINTED ______		PRINTED ______		PRINTED ______	
COMPANY ______		COMPANY ______		COMPANY ______		COMPANY ______	
REASON ______		REASON ______		REASON ______		REASON ______	

METHOD OF SHIPMENT: direct transport
SHIPMENT NO. ______
SPECIAL INSTRUCTION: ______

COMMENTS: If you cannot run all six analyses for 007SMWI548 Run hydraulic cond, porosity, bulk density from Shelby tube and Particle size, percent moisture, specific gravity from bag sample 007SMWI548A.

AFTER ANALYSIS, SAMPLES ARE TO BE:
- ☐ DISPOSED OF (ADDITIONAL FEE)
- ☐ STORED (90 DAYS MAX)
- ☐ STORED OVER 90 DAYS (ADDITIONAL FEE)
- ☐ RETURNED TO CUSTOMER

Appendix D

USGS Aquifer Pump Test Report

Specific Capacity Data

Hydrocone Data

AQUIFER TEST AT NAS MEMPHIS, NEAR MILLINGTON, TENNESSEE

December 1, 1995

An aquifer test was conducted at Naval Air Station (NAS) Memphis, near Millington, Tennessee to define the hydraulic properties of the fluvial deposits aquifer and the confining units in this shallow aquifer system. The aquifer was tested over a three day period beginning August 22, 1995. This test was conducted as part of a ground-water flow modelling effort that encompasses the entire base. The primary hydraulic properties to be quantified by the test were the lateral hydraulic conductivity of the fluvial deposits aquifer and the vertical hydraulic conductivities of the adjacent loess and Cockfield Formation confining units.

SITE

The aquifer-test site is located along the southern edge of the NAS Memphis airfield (fig. 1). A typical hydrogeologic column beneath the site shows the fluvial deposits aquifer comprises a series of interbedded sand and gravel deposits with some silt and clay (fig. 2). Thick loess deposits that extend to land surface confine the top of the fluvial deposits aquifer. The base of the fluvial deposits aquifer is bounded by the Cockfield Formation which consists of sand, silt, clay, and lignite (Kingsbury and Carmichael, 1995) and serves as the lower confining to semi-confining unit for the fluvial deposits aquifer. Sediments comprising the Cockfield Formation are lenticular and grade from clayey-sand at the base of the fluvial deposits aquifer to dense clay with very fine sand at about 105 ft below land surface.

The lateral flow direction in the fluvial deposits aquifer at the site is south-southwest towards Big Creek which is south of Navy Road (fig. 1). The normal vertical hydraulic gradient at the test site is downward from the loess to the fluvial deposits. Heads in the upper part of the underlying Cockfield Formation are approximately equal to those in the fluvial deposits indicating little potential for interchange of water between these units.

One production well and four observation wells were used for the test (table 1). The configuration of the production well and the three wells nearest the production well is shown in figures 1 and 2. The remaining observation well (BG-1LF) is screened in the lower part of the fluvial deposits aquifer, about 6,600 ft away from the site (fig. 1). This well was monitored for background water levels for detrending water-level responses measured in the fluvial deposits aquifer during the test.

PROCEDURES

Water levels were monitored continuously in the four observation wells for the duration of the test. The continuously monitored wells were checked by making periodic tape-downs before and after stressing the aquifer. Water levels were measured and recorded every 30 minutes in the background well, BG-1LF.

Drawdowns were estimated by subtracting the current water level from the water level just prior to stressing the aquifer. More sophisticated methods of estimating drawdowns were not employed since no trend appeared in the well BG-1LF (fig. 3).

Flow rates were monitored continuously by measuring the pressure drop across a constriction in the discharge line. Apparent variations of a few percent over the course of a day can be caused by temperature effects on the pressure transducer used to monitor flow rate. These measurements mostly served to record when the pump started or stopped and showed the well was pumped uniformly for the 24-hour test period.

The flow rate used in the analysis came from periodic discharge measurements using a stop watch and bucket. A 5-gallon bucket was used to measure the flow rate, 7.3 gpm, during the aquifer test. All produced water was discharged to the base's sanitary sewer system (fig. 1) at a point located about 100 ft west of the production well.

ANALYSIS

The final results from the test came from calibrating a variably-saturated, radial-flow model to the measured drawdowns. A variably-saturated model, VS2DT (Lappala and others, 1987; Healy, 1990), was used to accurately represent the fluvial deposits aquifer and adjacent confining units. Vertically, the model extended from land surface to 95 ft below land surface which is at the top of the sandy clay in the lower part of the Cockfield Formation.

The model has been discretized vertically into 36 rows from 0 to 95 ft below land surface (fig. 2). The thinnest rows are 1 ft thick at the contacts between the fluvial deposits aquifer and the adjacent confining units and the ends of the screened interval in the pumped well, where the greatest head changes are expected. The lower boundary of the model is no-flow. This is reasonable since the effects from 1 day of pumping at less than 10 gpm did not propagate to well WL-1C screened from 105 ft to 115 ft below land surface, except for those effects which are explained as resulting from deformation of the Cockfield Formation in the Aquifer Test section below.

Laterally, the model area covers about 2.5 miles from the production well to a no-flow boundary along the outer circumference. This is accomplished in 34 columns beginning with a 0.17 ft wide ring at the production well, with each successive ring being 1.35 times wider than the previous one (fig. 2; radially, only the first 600 ft are shown).

The production well was simulated as a high conductivity zone with K_{xy} = 1,000 ft/d and $K_z = 10^7$ ft/d. Water was removed from the lowermost node in the well and the simulator was allowed to apportion inflow across the well screen. The wellbore storage, S_{well}, associated with the production well was estimated. Ideally, the wellbore storage should equal 1, but estimated values can be less than this because of displacement by the pump string, mismatches between the simulated and actual well geometries, and not considering wellbore damage explicitly.

For the purposes of parameter estimation, it was assumed the hydraulic properties (K_{xy}, K_z, and S_s) of the aquifer or confining units could be described by a single value. Only a fraction of all the parameters that could be varied were estimated. The initial values of estimated parameters came from Theis analyses by a least-squares fit and literature values (Lappala and others, 1987; Domenico and Schwartz, 1990).

Parameter estimation was performed by minimizing the objective function with an optimization routine (Halford, 1992) coupled to VS2DT. The objective function is, $SS = \sum_{i=1}^{nobs} (w_i(\hat{s}_i - s_i))^2$, where w is a weight, $\hat{s}$ is calculated drawdown, s is measured drawdown, and $nobs$ is the number of observations. Root-mean-square, $RMS = \sqrt{\frac{SS}{nobs}}$, error also is reported. The log-parameters, $log(x)$, were estimated since the parameters, x, estimated are usually log-normally distributed. Log-parameters also are better behaved from a numerical perspective. Consequently, all sensitivities, covariances, and correlation coefficients are based on $\frac{\partial}{\partial \log x}\hat{s}$ not $\frac{\partial}{\partial x}\hat{s}$.

Another benefit from this type of analysis is that the covariance matrix, $[C]$, of the estimated parameters is computed. This matrix is ranked by the magnitude of the main diagonal since it is a rough indicator of the relative sensitivity of the model to a parameter. Specifically, the main diagonal is $C_{i,i} = \sum_{k=1}^{nobs} \frac{\partial \hat{s}_k}{\partial \log x_i}^2$. The off-diagonal components, $C_{i,j}$, describe the degree of interdependence between parameters but evaluation is difficult without some sort of normalization.

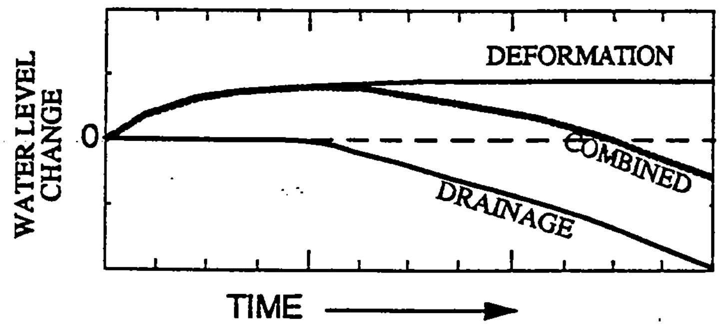
Normalization is achieved by computing correlation coefficients, $\rho_{i,j} = \frac{C_{i,j}}{\sqrt{C_{i,i}C_{j,j}}}$, similar to r^2 computed for a linear regression. If $\rho_{i,j}$ is ± 1, then x_i is a dependent variable of x_j or x_j is a dependent variable of x_i, depending on one's perspective. Alternately, if $\rho_{i,j}$ is 0, then x_i is an independent variable of x_j. Correlation coefficients greater than 0.95 usually indicate a pair of parameters are highly correlated and cannot be estimated independently (Hill, 1992).

AQUIFER TEST

Water-level responses were clearly detected in both observation wells screened in the fluvial deposits aquifer and in the well screened in the Cockfield Formation (fig. 3). The fluvial deposits wells responded in the expected manner, although a mystery pumping or injection stress markedly affected well 07MW08LF. As a result, only the record from 0 to 0.2 days and 0.8 to 1.1 days for this well were used in the analysis. This mystery stress only perturbed the water level in well WL-1F by 0.03 ft or less when the signal first became apparent (fig. 3). Drawdowns in well 07MW08LF were weighted 6 times (an arbitrary value) more than drawdowns in well WL-1F to account for the smaller drawdowns and shorter period of usable record associated with these measurements.

The water level in the Cockfield Formation well, WL-1C, rose in response to the pumping and then declined after pumping was stopped (fig. 3). These measurements were collected in triplicate by direct tapedowns, a float and shaft encoder, and a pressure transducer and are correct. The response is not an aberration since the same response also was observed in well WL-1C several days earlier during pre-test pumping of well WL-2F (fig. 4).

The reversed water-level response in well WL-1C appears to be an example of the "Noordbergum effect" (Verruijt, 1969, p. 368), where the change in pore pressure is dominated by deformation of the aquifer/confining unit system instead of ground-water flow (Wolf, 1970). In most of the documented field examples, water levels will rise for a few hours and then will begin to fall after ground-water flow begins to drain the pore spaces. Based on the duration of the observed water-level rise in well WL-1C, a high degree of confinement, relative to a pumping rate of 7.3 gpm, must exist between the upper part of the Cockfield Formation confining unit and the fluvial deposits aquifer since the test curves appear to reflect only deformation and not drainage effects, as compared to the generalized graph below.



Five parameters, K_{xy}, S_s, and S_s well of the fluvial deposits aquifer and K_{xy} and S_s of the loess, were estimated. Initial estimates of K_{xy} and S_s in the fluvial deposits were 17 ft/d and 0.24E-6 1/ft, respectively. This estimate came from a Theis analysis of the response in well WL-1F from 0.04 to 0.4 days after pumping began. Regarding the loess, the Van Genuchten (1980) parameters, α, β, and θ_r, that control the equations relating to moisture content, specific-moisture capacity, and relative hydraulic conductivity to pressure head in the loess, were taken from literature values for a lean clay and were not estimated.

The final parameter estimates of K_{xy} and S_s for the fluvial deposits aquifer are 5ft/d and 1.2E-6 1/ft, respectively. The vertical hydraulic conductivity of the loess, estimated to be 0.03 ft/d, is consistent with literature values for lean clays. The specific storage estimated for the loess, 60E-6 1/ft, is not excessively large given that it is an uncompacted material. All of the parameter estimates are provided in table 2. All of the parameters estimated were fairly independent of one another. The most highly correlated parameters were the specific storage of the fluvial deposits aquifer and the wellbore storage, 0.89 (table 3).

The calculated and measured drawdowns in well WL-1F mirrored one another throughout the test and the maximum difference was about 0.04 ft (fig. 5). The weighted error statistics were $SS = 0.79\ \text{ft}^2$, $RMSE = 0.30\ \text{ft}$, and an $Average = 0.0026\ \text{ft}$.

A comparison between a Theis curve and the measured drawdowns plotted on a log-log scale shows how leaky the system is (fig. 6). Considering the response seen in well WL-1C, nearly all of the leakage is assumed to be from the loess. The transmissivity of the fluvial deposits aquifer, estimated by fitting the data to the flow model, was about 200 ft^2/d. Transmissivity estimates from a Theis fit to the drawdowns in wells WL-1F and 07MW08LF were 640 ft^2/d and 1,200 ft^2/d, respectively. One interpretation of these results is that the transmissivity of the fluvial deposits aquifer is 200 ft^2/d and, thus, amounts proportional to the pumping rate of only 2.3 gpm and 1.2 gpm are being drawn radially past wells WL-1F and 07MW08LF, respectively.

Calculated drawdowns at the end of the test showed pumping effects propagated up to the water table and down to about 100 ft below land surface (fig. 7). After 1 day of pumping, the loess, fluvial deposits, and Cockfield Formation were supplying 4.1, 2.7, and 0.5 gpm to the well from storage, respectively. If the producing well was 100% efficient, the drawdown would have been 9.8 ft instead of the measured value of 27.2 ft. Thus, the well efficiency was 36% for a flow rate of 7.3 gpm.

SELECTED REFERENCES

Domenico, P.A. and Schwartz, F.W., 1990, Physical and Chemical Hydrogeology: New York, John Wiley and Sons, Inc., 824 p.

Gill, P.E., Murray, Walter, and Wright, M.H., 1981, Practical Optimization: Orlando, Fla., Academic Press Inc., 401 p.

Halford, K.J., 1992, Incorporating Reservoir Characteristics for Automatic History Matching: Baton Rouge, La., Louisiana State University, Ph.D. dissertation, 150 p.

Healy R. W., 1990, Simulation of Solute Transport in Variably Saturated Porous Media with Supplemental Information on Modifications to the U.S. Geological Survey's Computer Program VS2D: U.S. Geological Survey WRIR 90-4025, 125p.

Hill, M.C., 1992, A Computer Program (MODFLOWP) for Estimating Parameters of a Transient, Three-Dimensional, Ground-Water Flow Model Using Non-Linear Regression, U.S. Geological Survey Open-File Report 91-484, 358 pp.

Kingsbury, J.A. and Carmichael, J.K., 1995, Hydrogeology of post-Wilcox Group stratigraphic units in the area of the Naval Air Station Memphis, near Millington, Tennessee: U.S. Geological Survey WRIR 95-4011, 1 plate.

Lappala E.G., Healy R. W., and Weeks E.P., 1987, Documentation of Computer Program VS2D to Solve the Equations of Fluid Flow in Variably Saturated Porous Media: U.S. Geological Survey WRIR 83-4009, 184p.

McDonald, M.G. and Harbaugh, A.W., 1988, A Modular Three-Dimensional Finite- Difference Ground-Water Flow Model, U.S. Geological Survey Techniques of Water-Resources Investigations, book 6, chap. A1, 576 pp.

Van Genuchten, M. Th., 1980, A Closed-Form Equation for Predicting the Hydraulic Conductivity of Unsaturated Soils, Soil Science of America, v. 44, no. 5, p. 892-898.

Verruijt, A. 1969, Elastic storage of aquifers. In: Flow Through Porous Media, edited by R. J. M. De Wiest. Academic Press, New York. pp. 331-376.

Wolff, R. G. 1970, Relationship between horizontal strain near a well and reverse water level fluctuation. Water Resources Research. v. 6, pp. 1721-1728.

Table 1: Wells used for aquifer tests at NAS Memphis.

WELL	INTERVAL SCREENED, IN FT	DIAMETER, IN INCHES	DISTANCE FROM PRODUCTION WELL, IN FT	AQUIFER (A) or CONFINING UNIT (C)
WL-2F	40-70	4	0	Fluvial (A)
WL-1C	105-115	4	79	Cockfield (C)
WL-1F	59-69	4	76	Fluvial (A)
07MW08LF	66-76	2	555	Fluvial (A)
BG-1LF	55-65	2	6,600	Fluvial (A)

Table 2: Aquifer and confining-unit properties determined by aquifer test.

[Values of K_{xy}, K_z, and S_s estimated from aquifer test unless otherwise noted; all thicknesses were measured.]

AQUIFER (A)/ CONFINING UNIT (C)	K_{xy}, ft/day	K_z, ft/day	S_s, 10^{-6}/ft	b, ft	S_{well}	n	α (ft), θ_r, β [b]
Loess (C)	0.03[a]	0.035	58.	34	NA	0.47	3.0, 0.2, 2.5
Fluvial (A)	5.3	0.5[a]	1.2	40	0.38	0.3[a]	NA
Cockfield (C)	3.[a]	0.003[a]	1.2	35	NA	0.3[a]	NA

[a] Assumed based on literature values or previous experience.
[b] Van Genuchten parameters are literature values for a lean clay (Lappala and others, 1987)

Table 3: Correlation coefficients between parameters estimated from the aquifer test.

ESTIMATED PARAMETERS	CORRELATION COEFFICIENTS, $\rho_{i,j}$				
K_{xy} Fluvial	1.00				
K_z Loess	0.60	1.00			
S_s Well	0.35	0.23	1.00		
S_s Loess	0.03	0.15	0.36	1.00	
S_s Fluvial-Upper Cockfield	-0.31	-0.15	0.89	-0.70	1.00
$\rho_{i,j} = \frac{C_{i,j}}{\sqrt{C_{i,i}C_{j,j}}}$	K_{xy} Fluvial	K_z Loess	S_s Well	S_s Loess	S_s Fluvial-Upper Cockfield
MAIN DIAGONAL, $C_{i,i}$	1,000.	260.	35.	31.	8.0

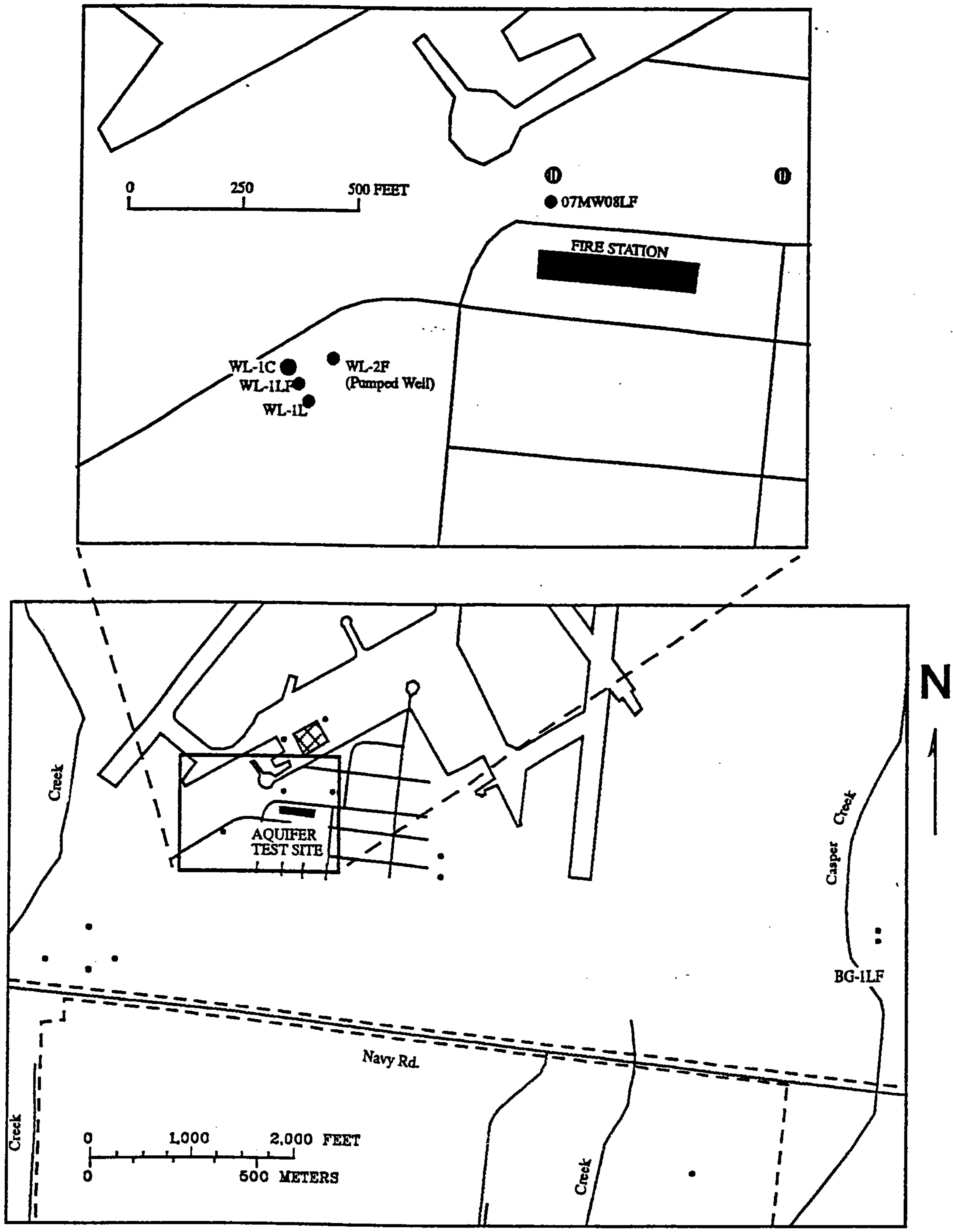


Figure 1.-- Location of aquifer test site, background observation well BG-1LF, and nearby hydrologic features.

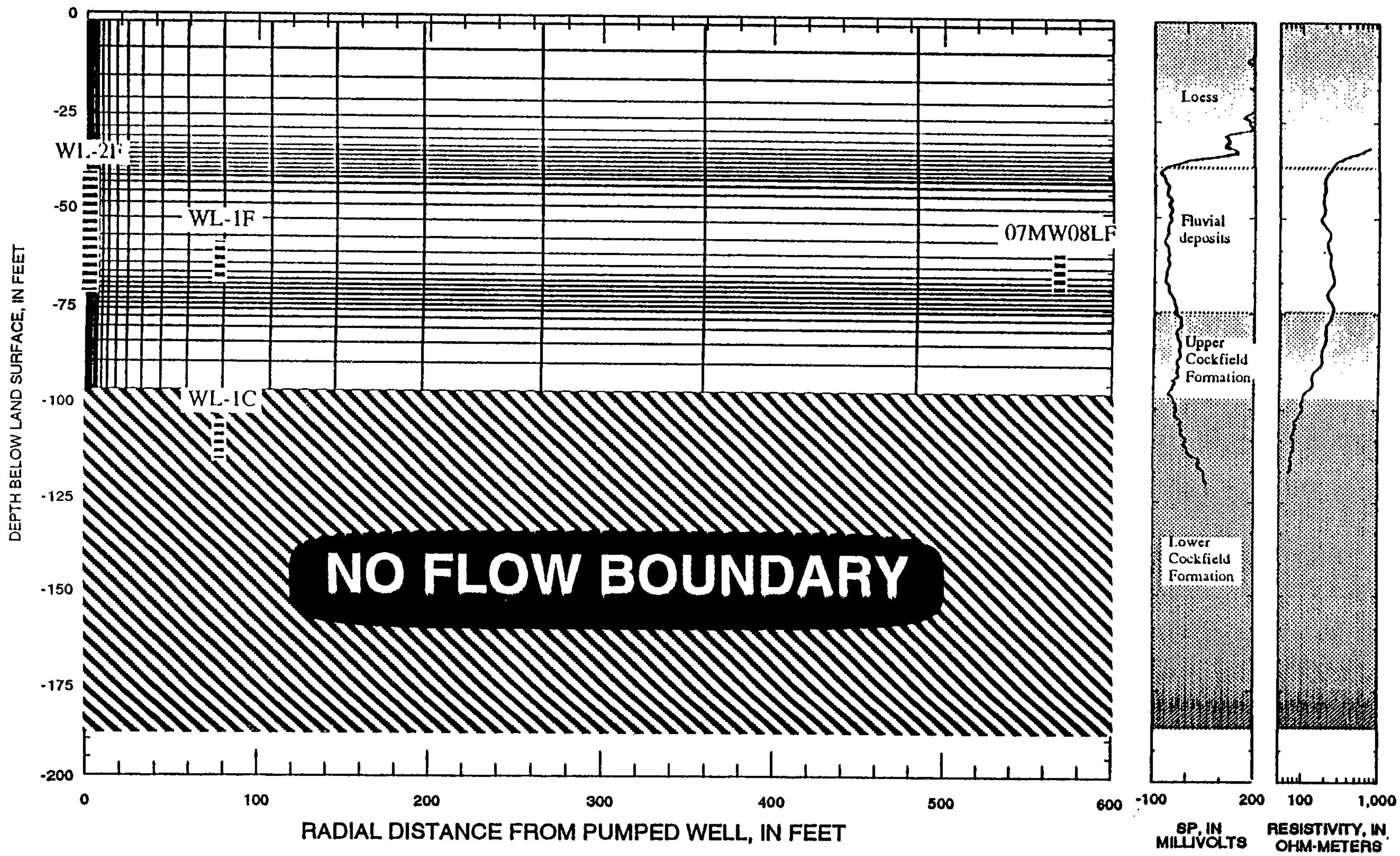


Figure 2.-- Cross-section showing well locations for aquifer test at NAS Memphis and the spontaneous potential (SP) and long-normal resistivity logs from well WL-1C.

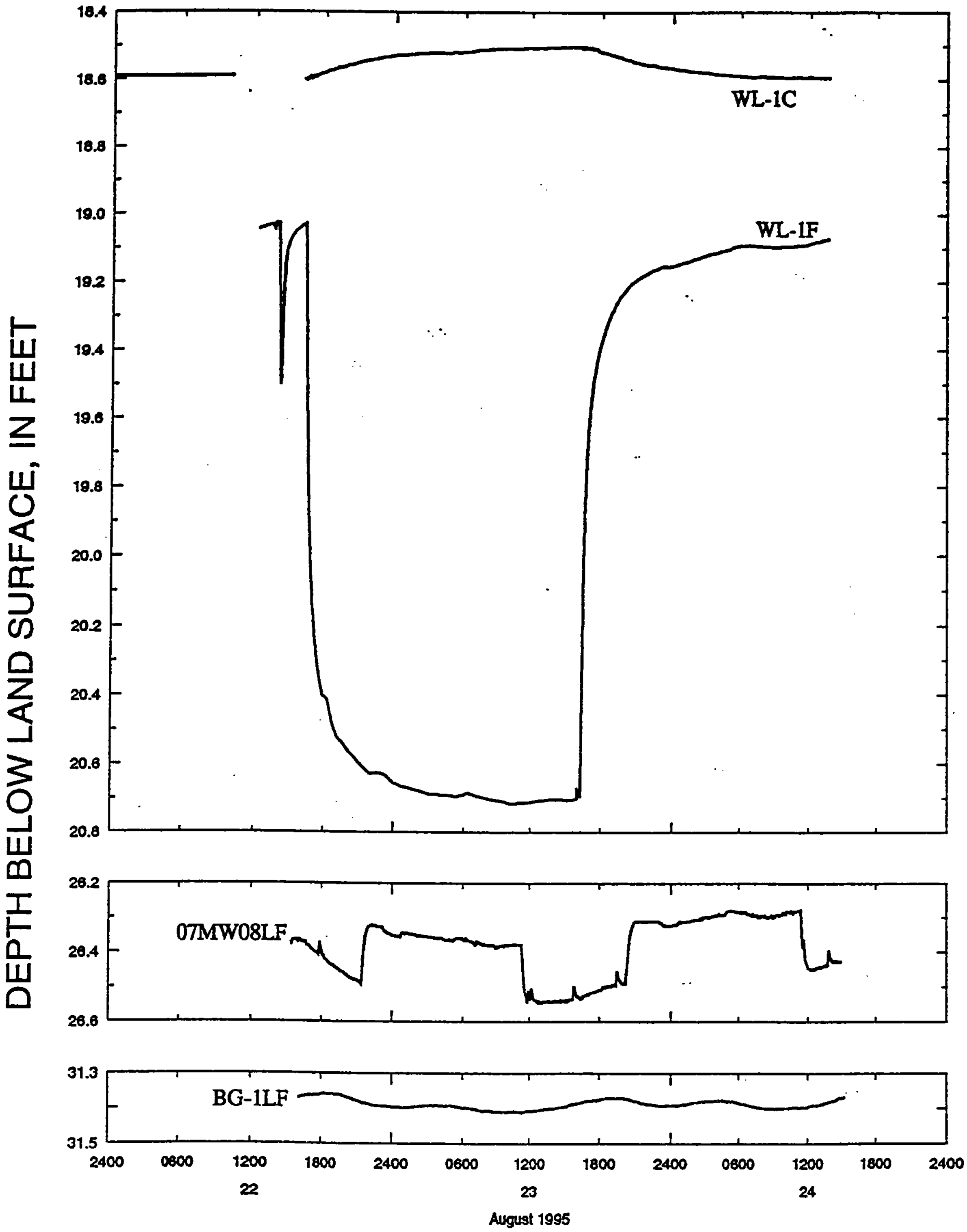


Figure 3.-- Water-level change in all four observation wells during the aquifer test.

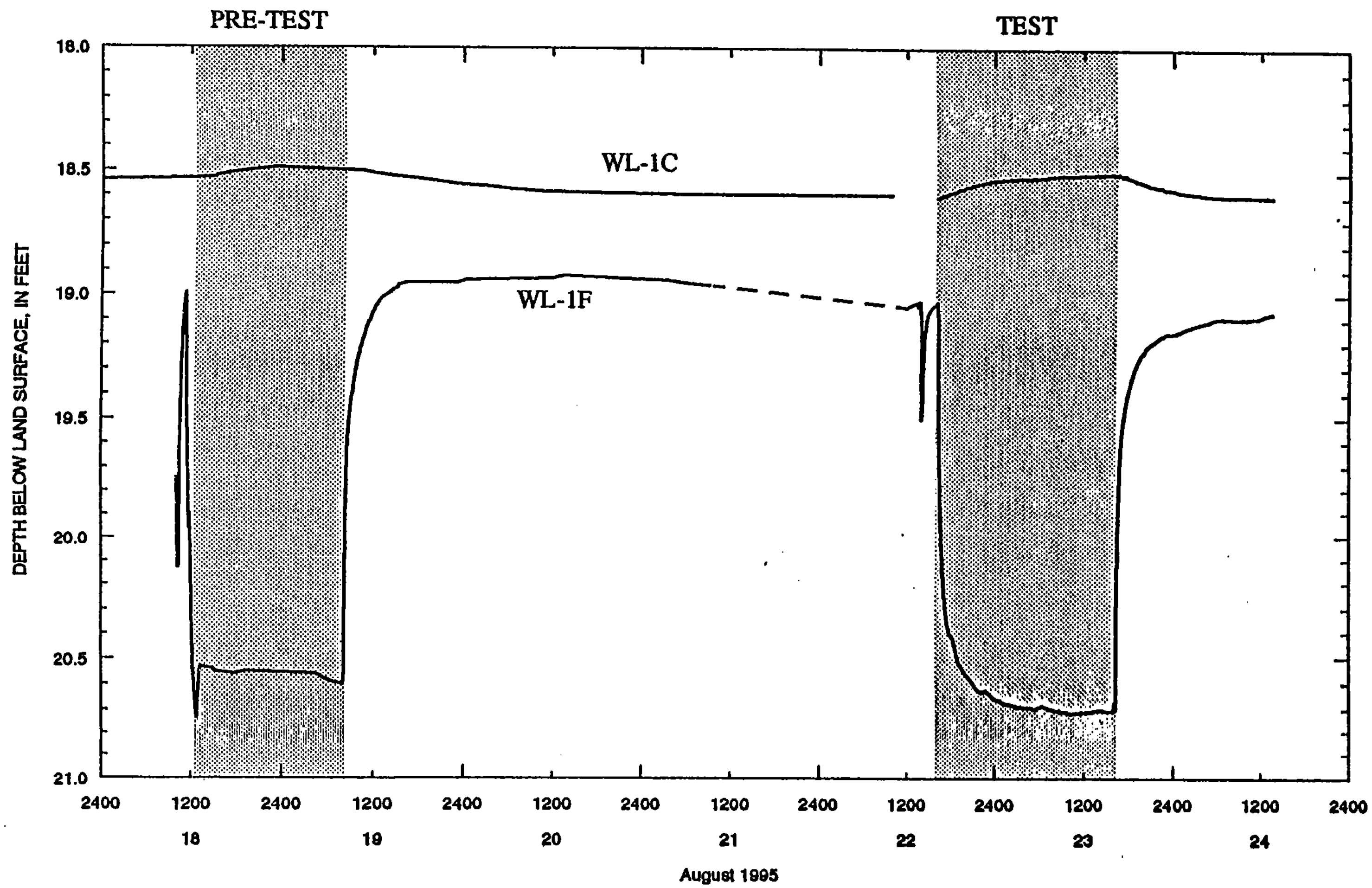


Figure 4.-- Water-level change at wells WL-1C and WL-1F from five days before the test to one day afterwards.

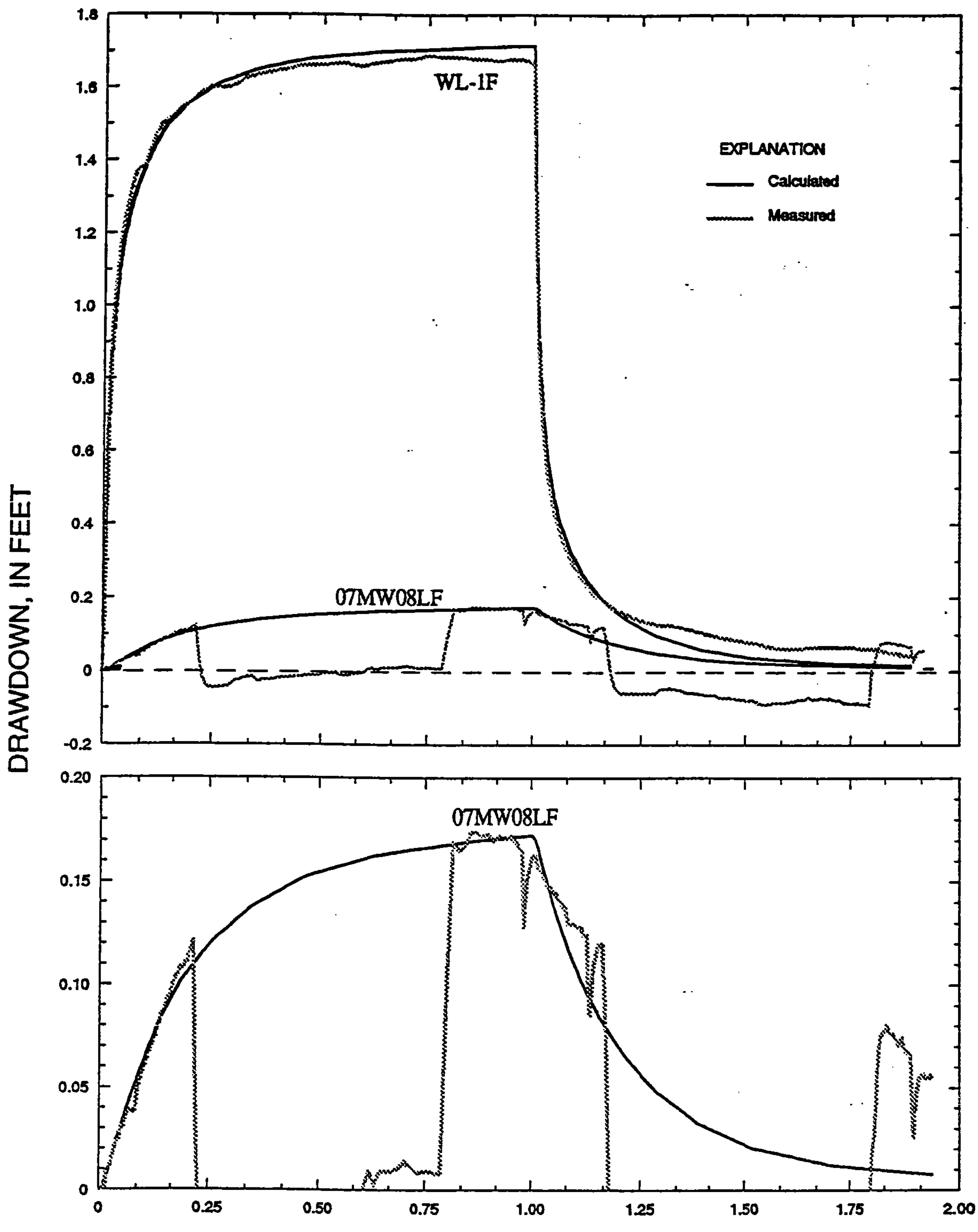


Figure 5.-- Calculated and measured drawdowns in response to pumping the fluvial deposits aquifer for 1 day at 7.3 gallons per minute.

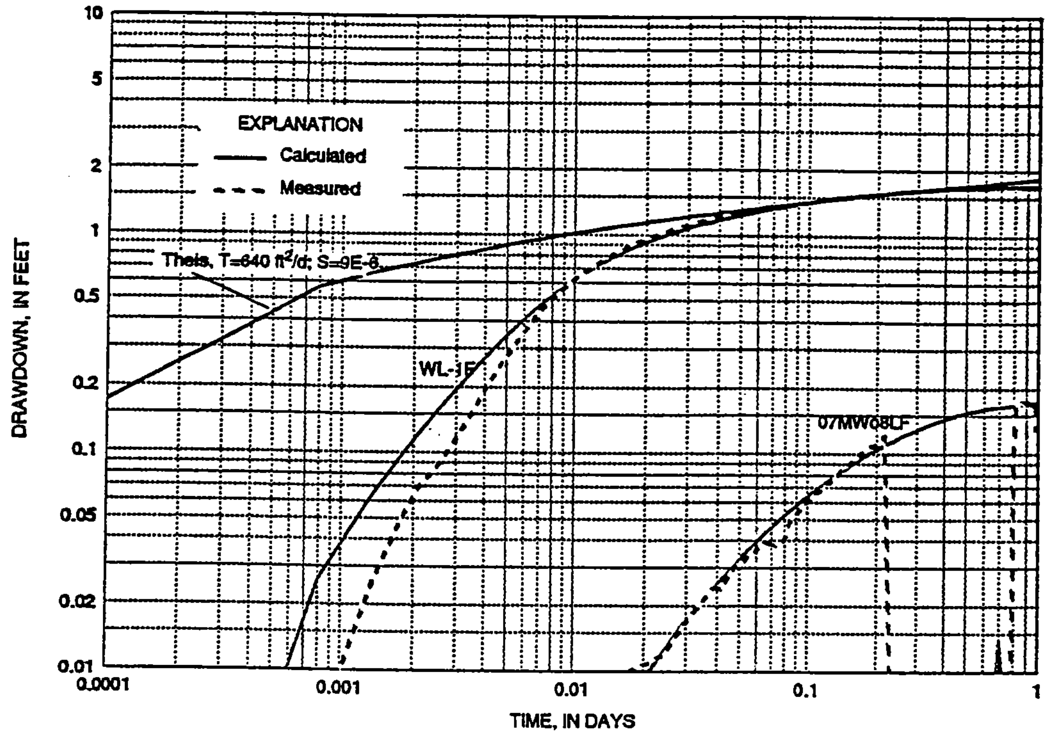


Figure 6.-- Calculated and measured drawdowns in response to pumping the fluvial deposits aquifer for 1 day at 7.3 gallons per minute on a log-log plot with a Theis response shown.

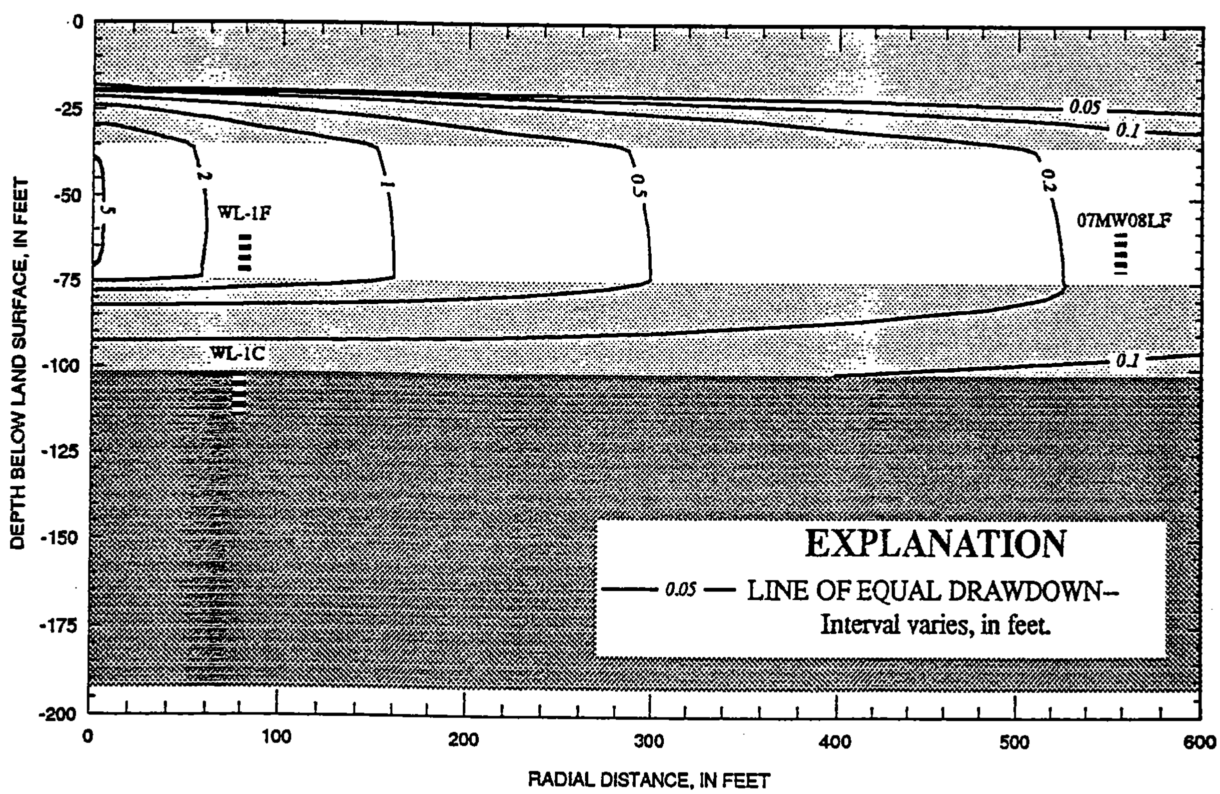


Figure 7.-- Calculated drawdowns radially across the fluvial deposits aquifer and adjacent confining units prior to cessation of pumping from the fluvial deposits aquifer.

Specific Capacity Data

****
DETERMINATION OF AQUIFER PROPERTIES BASED ON ANALYSIS OF
SPECIFIC CAPACITY TESTS
****

Copied from: Bradbury, K. R. and Rothschild, E. R., 1985. A computerized technique for estimating the hydraulic conductivity of aquifers from specific capacity data, Ground Water, 23(2), pp. 240-246.

WELL NUMBER 007G07UC

```
WELL DIAMETER (IN) =          2
STATIC WATER LEVEL (FT) =     28.7
DEPTH TO WATER DURING TEST (FT) =             50.8
THE LENGTH OF THE TEST (HR) =                 .1
PUMPING RATE (GPM) =          .8
THICKNESS OF AQUIFER (FT) =                   75
OPEN INTERVAL (FT) =          10
STORAGE COEFFICIENT =         .0000672
WELL-LOSS COEFFICIENT =       .1


SPECIFIC CAPACITY (GPM/FT) =  .0361991

TRANSMISSIVITY:  (FT*FT/SEC) =  4.747001E-04
                 (FT*FT/DAY) =  41.01409
                 (GAL/DAY/FT) =  306.8059
           USING A STORAGE COEFFICIENT =  .0000672
           NUMBER OF ITERATIONS =  2

HYDRAULIC CONDUCTIVITY:  (FT/SEC) =  6.329335E-06
                         (FT/DAY) =  .5468546
                         (GAL/DAY/FT*FT) =  3.633038
```

WELL NUMBER 007G03UC

```
WELL DIAMETER (IN) =          2
STATIC WATER LEVEL (FT) =     28.38
DEPTH TO WATER DURING TEST (FT) =             43.41
THE LENGTH OF THE TEST (HR) =                 .17
PUMPING RATE (GPM) =          2
THICKNESS OF AQUIFER (FT) =                   75
OPEN INTERVAL (FT) =          10
STORAGE COEFFICIENT =         .0000672
WELL-LOSS COEFFICIENT =       .1


SPECIFIC CAPACITY (GPM/FT) =  .1330672

TRANSMISSIVITY:  (FT*FT/SEC) =  1.788767E-03
```

(FT*FT/DAY) = 154.5495
(GAL/DAY/FT) = 1156.108
USING A STORAGE COEFFICIENT = .0000672
NUMBER OF ITERATIONS = 3

HYDRAULIC CONDUCTIVITY: (FT/SEC) = 2.385023E-05
(FT/DAY) = 2.06066
(GAL/DAY/FT*FT) = 13.69003

WELL NUMBER 007G01UC

WELL DIAMETER (IN) = 2
STATIC WATER LEVEL (FT) = 27
DEPTH TO WATER DURING TEST (FT) = 39.96
THE LENGTH OF THE TEST (HR) = .27
PUMPING RATE (GPM) = .57
THICKNESS OF AQUIFER (FT) = 80
OPEN INTERVAL (FT) = 10
STORAGE COEFFICIENT = .0000672
WELL-LOSS COEFFICIENT = .1

SPECIFIC CAPACITY (GPM/FT) = 4.398149E-02

TRANSMISSIVITY: (FT*FT/SEC) = 6.256695E-04
(FT*FT/DAY) = 54.05784
(GAL/DAY/FT) = 404.3797
USING A STORAGE COEFFICIENT = .0000672
NUMBER OF ITERATIONS = 2

Average K for
0701UC and 0701UC*

[redacted]

6.3906134×10^{-4}
5.5214865
36.682109

WELL NUMBER 007G05UC

WELL DIAMETER (IN) = 2
STATIC WATER LEVEL (FT) = 26.3
DEPTH TO WATER DURING TEST (FT) = 28.58
THE LENGTH OF THE TEST (HR) = .07
PUMPING RATE (GPM) = .2
THICKNESS OF AQUIFER (FT) = 100
OPEN INTERVAL (FT) = 10
STORAGE COEFFICIENT = .0000672
WELL-LOSS COEFFICIENT = .1

SPECIFIC CAPACITY (GPM/FT) = 8.771928E-02

TRANSMISSIVITY: (FT*FT/SEC) = 1.559166E-03
(FT*FT/DAY) = 134.7119
(GAL/DAY/FT) = 1007.713
USING A STORAGE COEFFICIENT = .0000672
NUMBER OF ITERATIONS = 2

[redacted]

Average K for 0705UC and 0705UC*
2.59624×10-4
2.243151
14.902416

WELL NUMBER 007G05UC*

WELL DIAMETER (IN) = 2
STATIC WATER LEVEL (FT) = 26.7
DEPTH TO WATER DURING TEST (FT) = 29.82
THE LENGTH OF THE TEST (HR) = .233
PUMPING RATE (GPM) = .625
THICKNESS OF AQUIFER (FT) = 100
OPEN INTERVAL (FT) = 10
STORAGE COEFFICIENT = .0000672
WELL-LOSS COEFFICIENT = .1

SPECIFIC CAPACITY (GPM/FT) = .2003206

TRANSMISSIVITY: (FT*FT/SEC) = 3.633314E-03
(FT*FT/DAY) = 313.9183
(GAL/DAY/FT) = 2348.266
USING A STORAGE COEFFICIENT = .0000672
NUMBER OF ITERATIONS = 3

HYDRAULIC CONDUCTIVITY: (FT/SEC) = (3.633314E-05)
(FT/DAY) = (3.139183)
(GAL/DAY/FT*FT) = (20.85522)

WELL NUMBER 007G09UC*

WELL DIAMETER (IN) = 2
STATIC WATER LEVEL (FT) = 28.15
DEPTH TO WATER DURING TEST (FT) = 31.33
THE LENGTH OF THE TEST (HR) = .2
PUMPING RATE (GPM) = .39
THICKNESS OF AQUIFER (FT) = 80
OPEN INTERVAL (FT) = 10
STORAGE COEFFICIENT = .0000672
WELL-LOSS COEFFICIENT = .1

SPECIFIC CAPACITY (GPM/FT) = .1226415

TRANSMISSIVITY: (FT*FT/SEC) = 1.760615E-03
(FT*FT/DAY) = 152.1172
(GAL/DAY/FT) = 1137.912
USING A STORAGE COEFFICIENT = .0000672
NUMBER OF ITERATIONS = 3

Average of 0709UC*, 0709UC**, 0709UC***

[redacted]

1.694686×10-4
1.464209
9.727499666667

WELL NUMBER 007G09UC**

```
WELL DIAMETER (IN) =          2
STATIC WATER LEVEL (FT) =     25.85
DEPTH TO WATER DURING TEST (FT) =             34.15
THE LENGTH OF THE TEST (HR) =                 .12
PUMPING RATE (GPM) =          .714
THICKNESS OF AQUIFER (FT) =                   80
OPEN INTERVAL (FT) =          10
STORAGE COEFFICIENT =         .0000672
WELL-LOSS COEFFICIENT =       .1


SPECIFIC CAPACITY (GPM/FT) =  8.602408E-02

TRANSMISSIVITY:  (FT*FT/SEC) =  1.221593E-03
                 (FT*FT/DAY) =  105.5456
                 (GAL/DAY/FT) =  789.5339
           USING A STORAGE COEFFICIENT =  .0000672
           NUMBER OF ITERATIONS =  2

HYDRAULIC CONDUCTIVITY:  (FT/SEC) =  1.526991E-05
                         (FT/DAY) =  1.31932
                         (GAL/DAY/FT*FT) =  8.764927
```

WELL NUMBER 007G04UC** ignore

```
WELL DIAMETER (IN) =          2
STATIC WATER LEVEL (FT) =     29.1
DEPTH TO WATER DURING TEST (FT) =             45.69
THE LENGTH OF THE TEST (HR) =                 .33
PUMPING RATE (GPM) =          .5
THICKNESS OF AQUIFER (FT) =                   111
OPEN INTERVAL (FT) =          10
STORAGE COEFFICIENT =         .0000672
WELL-LOSS COEFFICIENT =       .1


SPECIFIC CAPACITY (GPM/FT) =  3.013864E-02

TRANSMISSIVITY:  (FT*FT/SEC) =  6.00501E-04
                 (FT*FT/DAY) =  51.88329
                 (GAL/DAY/FT) =  388.1129
           USING A STORAGE COEFFICIENT =  .0000672
           NUMBER OF ITERATIONS =  2

HYDRAULIC CONDUCTIVITY:  (FT/SEC) =  5.409919E-06
                         (FT/DAY) =  .467417
                         (GAL/DAY/FT*FT) =  3.105294
```

WELL NUMBER 007G08UF

```
WELL DIAMETER (IN) =          2
STATIC WATER LEVEL (FT) =     25.85
DEPTH TO WATER DURING TEST (FT) =             29.61
THE LENGTH OF THE TEST (HR) =                 .083
PUMPING RATE (GPM) =          2.5
THICKNESS OF AQUIFER (FT) =                   79
OPEN INTERVAL (FT) =          10
STORAGE COEFFICIENT =         .0000672
WELL-LOSS COEFFICIENT =       .1


SPECIFIC CAPACITY (GPM/FT) =  .6648941

TRANSMISSIVITY:  (FT*FT/SEC) =  9.521948E-03
                 (FT*FT/DAY) =  822.6963
                 (GAL/DAY/FT) =  6154.18
           USING A STORAGE COEFFICIENT =  .0000672
           NUMBER OF ITERATIONS =  3

HYDRAULIC CONDUCTIVITY:  (FT/SEC) =  1.20531E-04
                         (FT/DAY) =  10.41388
                         (GAL/DAY/FT*FT) =  69.18478

WELL NUMBER 007G08LF


WELL DIAMETER (IN) =          2
STATIC WATER LEVEL (FT) =     26.28
DEPTH TO WATER DURING TEST (FT) =             27.52
THE LENGTH OF THE TEST (HR) =                 .083
PUMPING RATE (GPM) =          3
THICKNESS OF AQUIFER (FT) =                   79
OPEN INTERVAL (FT) =          10
STORAGE COEFFICIENT =         .0000672
WELL-LOSS COEFFICIENT =       .1


SPECIFIC CAPACITY (GPM/FT) =  2.419364

TRANSMISSIVITY:  (FT*FT/SEC) =  3.520844E-02
                 (FT*FT/DAY) =  3042.009
                 (GAL/DAY/FT) =  22755.75
           USING A STORAGE COEFFICIENT =  .0000672
           NUMBER OF ITERATIONS =  3

HYDRAULIC CONDUCTIVITY:  (FT/SEC) =  4.456764E-04
                         (FT/DAY) =  38.50644
                         (GAL/DAY/FT*FT) =  255.8182

WELL NUMBER 007G05LF


WELL DIAMETER (IN) =          2
STATIC WATER LEVEL (FT) =     26.18
DEPTH TO WATER DURING TEST (FT) =             31.47
```

```
STORAGE COEFFICIENT =         .0000672
WELL-LOSS COEFFICIENT =       .1


SPECIFIC CAPACITY (GPM/FT) =  5.250998E-02

TRANSMISSIVITY:  (FT*FT/SEC) =  7.252118E-04
                 (FT*FT/DAY) =  62.6583
                 (GAL/DAY/FT) =  468.7154
           USING A STORAGE COEFFICIENT =  .0000672
           NUMBER OF ITERATIONS =  2

HYDRAULIC CONDUCTIVITY:  (FT/SEC) =  9.297587E-06
                         (FT/DAY) =  .8033115
                         (GAL/DAY/FT*FT) =  5.336815

WELL NUMBER 007G09UC***


WELL DIAMETER (IN) =          2
STATIC WATER LEVEL (FT) =     27.3
DEPTH TO WATER DURING TEST (FT) =           60
THE LENGTH OF THE TEST (HR) =               .133
PUMPING RATE (GPM) =          2.5
THICKNESS OF AQUIFER (FT) =                 78
OPEN INTERVAL (FT) =          10
STORAGE COEFFICIENT =         .0000672
WELL-LOSS COEFFICIENT =       .1


SPECIFIC CAPACITY (GPM/FT) =  7.645261E-02

TRANSMISSIVITY:  (FT*FT/SEC) =  1.057913E-03
                 (FT*FT/DAY) =  91.40365
                 (GAL/DAY/FT) =  683.745
           USING A STORAGE COEFFICIENT =  .0000672
           NUMBER OF ITERATIONS =  2

HYDRAULIC CONDUCTIVITY:  (FT/SEC) =  1.356298E-05
                         (FT/DAY) =  1.171842
                         (GAL/DAY/FT*FT) =  7.785152

WELL NUMBER 007G01UC*


WELL DIAMETER (IN) =          2
STATIC WATER LEVEL (FT) =     28.87
DEPTH TO WATER DURING TEST (FT) =           48.55
THE LENGTH OF THE TEST (HR) =               .133
PUMPING RATE (GPM) =          1.5
THICKNESS OF AQUIFER (FT) =                 78
OPEN INTERVAL (FT) =          10
STORAGE COEFFICIENT =         .0000672
WELL-LOSS COEFFICIENT =       .1
```

THE LENGTH OF THE TEST (HR) = .083
PUMPING RATE (GPM) = 3.5
THICKNESS OF AQUIFER (FT) = 75
OPEN INTERVAL (FT) = 10
STORAGE COEFFICIENT = .0000672
WELL-LOSS COEFFICIENT = .1

SPECIFIC CAPACITY (GPM/FT) = .6616266

TRANSMISSIVITY: (FT*FT/SEC) = 8.999351E-03
(FT*FT/DAY) = 777.544
(GAL/DAY/FT) = 5816.418
USING A STORAGE COEFFICIENT = .0000672
NUMBER OF ITERATIONS = 3

HYDRAULIC CONDUCTIVITY: (FT/SEC) = 1.199914E-04
(FT/DAY) = 10.36725
(GAL/DAY/FT*FT) = 68.87504

WELL NUMBER 007G01LE

WELL DIAMETER (IN) = 2
STATIC WATER LEVEL (FT) = 27.15
DEPTH TO WATER DURING TEST (FT) = 27.91
THE LENGTH OF THE TEST (HR) = .033
PUMPING RATE (GPM) = 2.5
THICKNESS OF AQUIFER (FT) = 75
OPEN INTERVAL (FT) = 10
STORAGE COEFFICIENT = .0000672
WELL-LOSS COEFFICIENT = .1

SPECIFIC CAPACITY (GPM/FT) = 3.289486

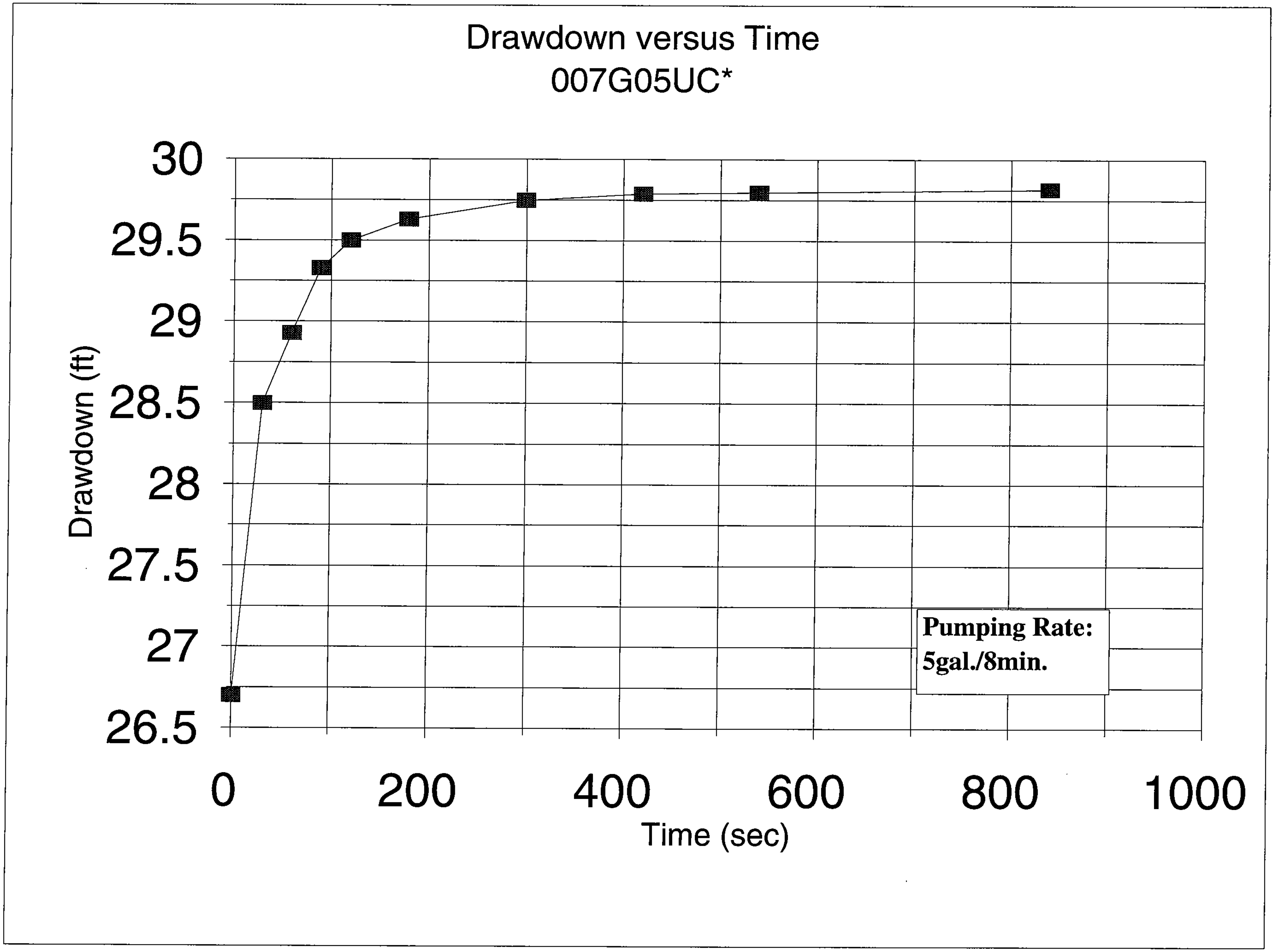
TRANSMISSIVITY: (FT*FT/SEC) = 4.514564E-02
(FT*FT/DAY) = 3900.583
(GAL/DAY/FT) = 29178.31
USING A STORAGE COEFFICIENT = .0000672
NUMBER OF ITERATIONS = 3

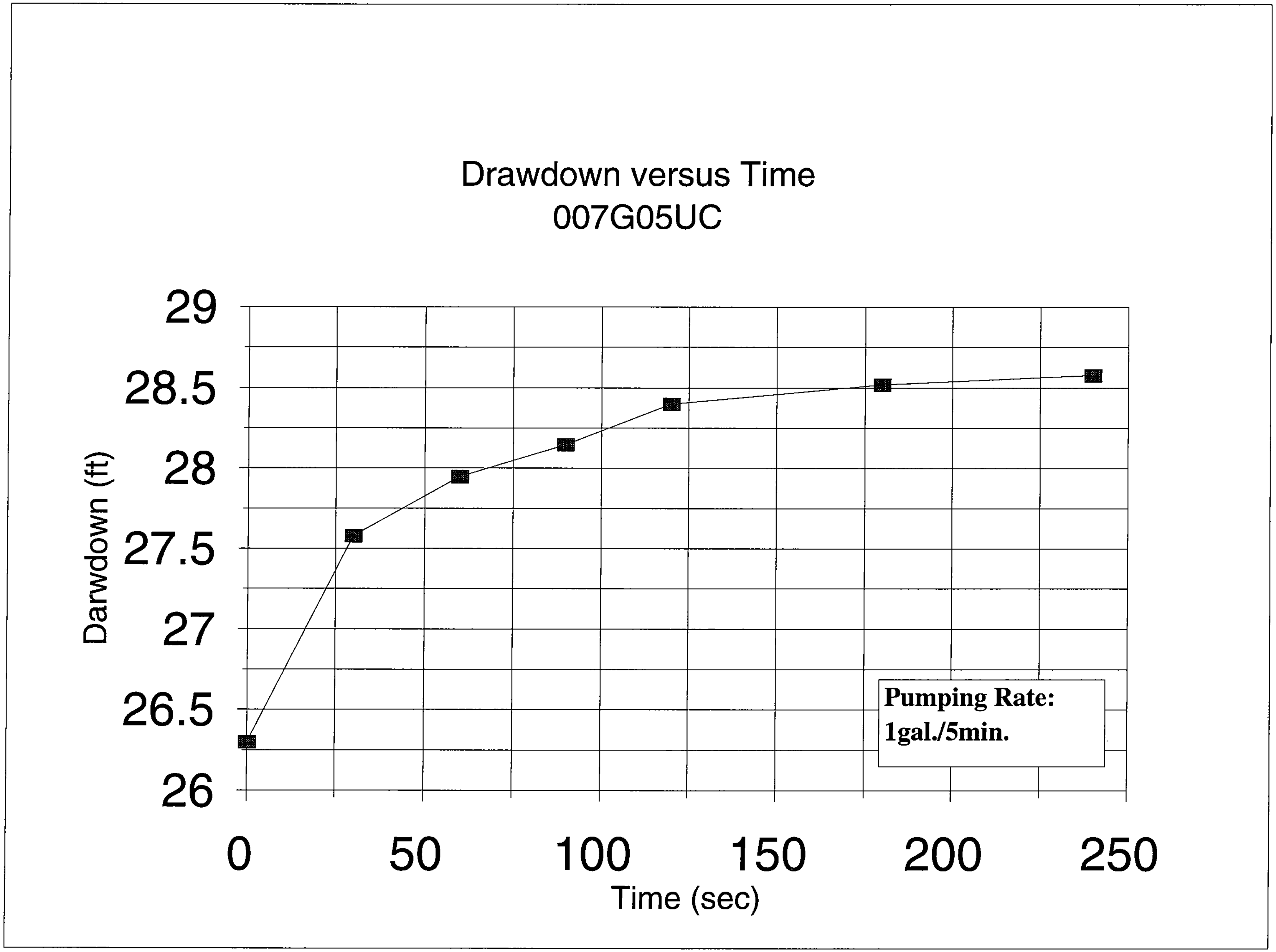
HYDRAULIC CONDUCTIVITY: (FT/SEC) = 6.019418E-04
(FT/DAY) = 52.00777
(GAL/DAY/FT*FT) = 345.5146

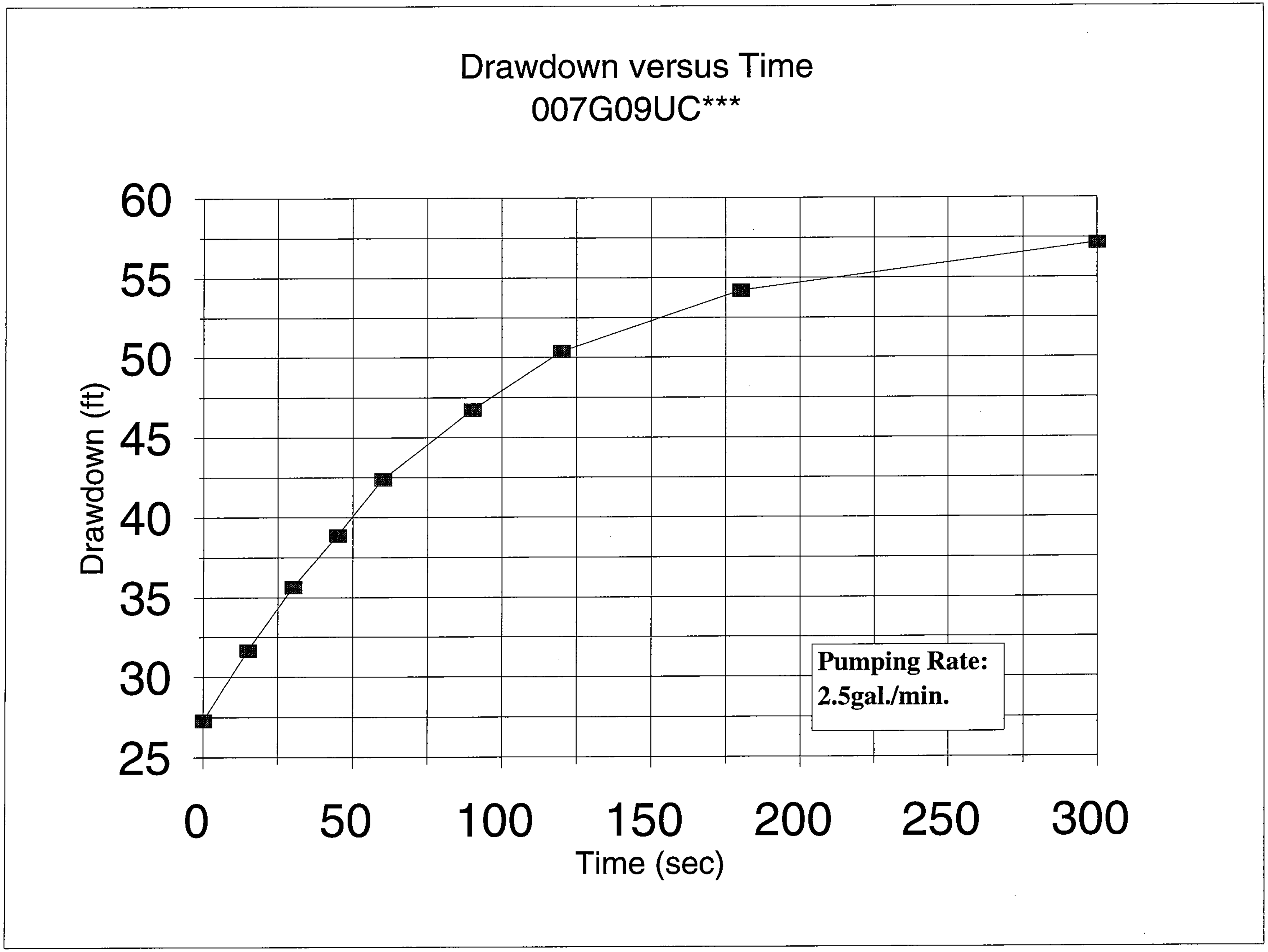
WELL NUMBER 007G08UC

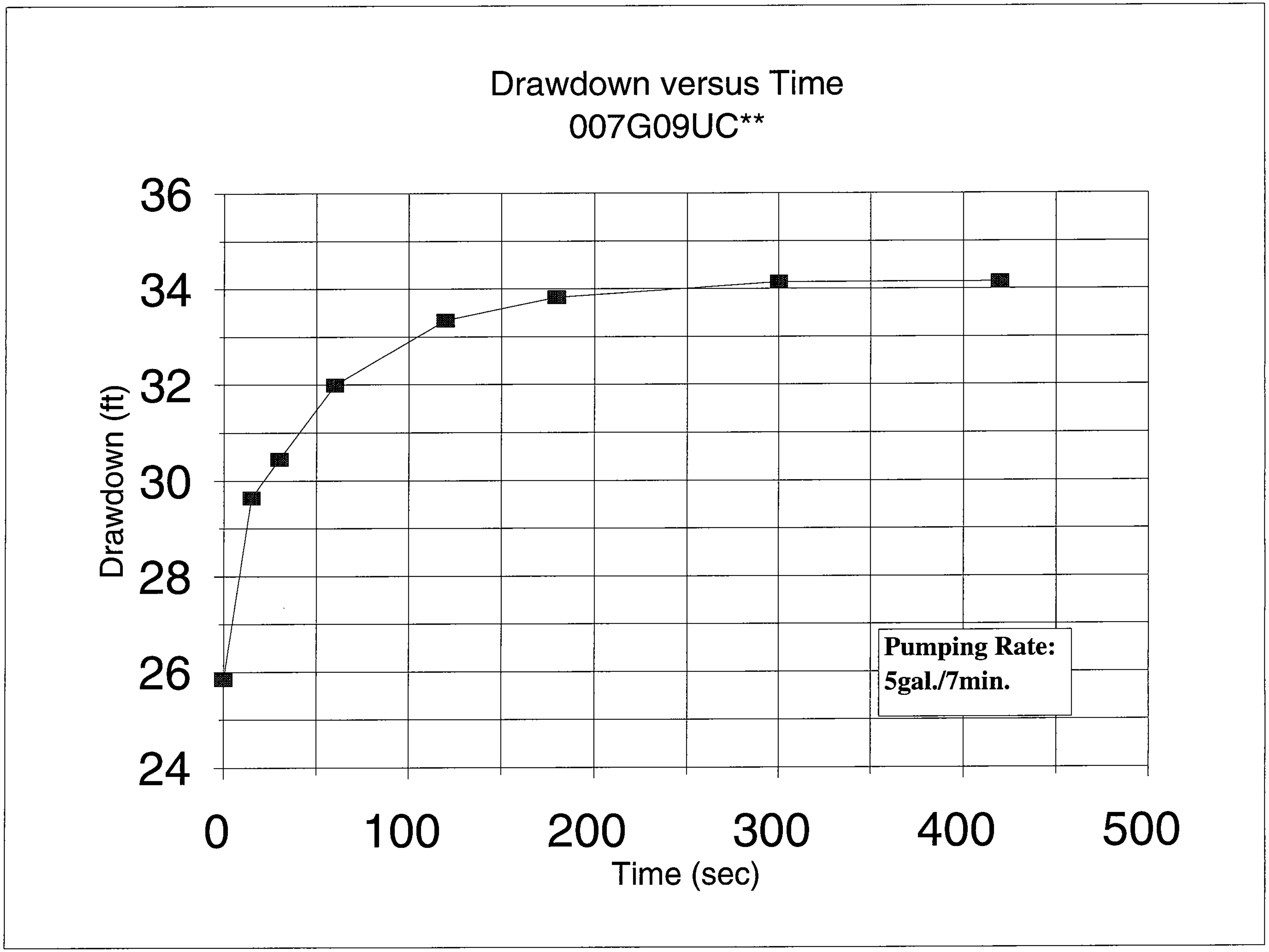
WELL DIAMETER (IN) = 2
STATIC WATER LEVEL (FT) = 28.89
DEPTH TO WATER DURING TEST (FT) = 76.5
THE LENGTH OF THE TEST (HR) = .167
PUMPING RATE (GPM) = 2.5
THICKNESS OF AQUIFER (FT) = 78
OPEN INTERVAL (FT) = 10

```
SPECIFIC CAPACITY (GPM/FT) =  7.621953E-02

TRANSMISSIVITY:  (FT*FT/SEC) =  1.054646E-03
                 (FT*FT/DAY) =  91.12138
                 (GAL/DAY/FT) =  681.6335
           USING A STORAGE COEFFICIENT =  .0000672
           NUMBER OF ITERATIONS =  2

HYDRAULIC CONDUCTIVITY:  (FT/SEC) =  1.35211E-05
                         (FT/DAY) =  1.168223
                         (GAL/DAY/FT*FT) =  7.76111

THE NUMBER OF WELLS IN THIS RECORD IS  15
******************************************************************
DETERMINATION OF AQUIFER PROPERTIES BASED ON ANALYSIS OF
                 SPECIFIC CAPACITY TESTS
******************************************************************
```

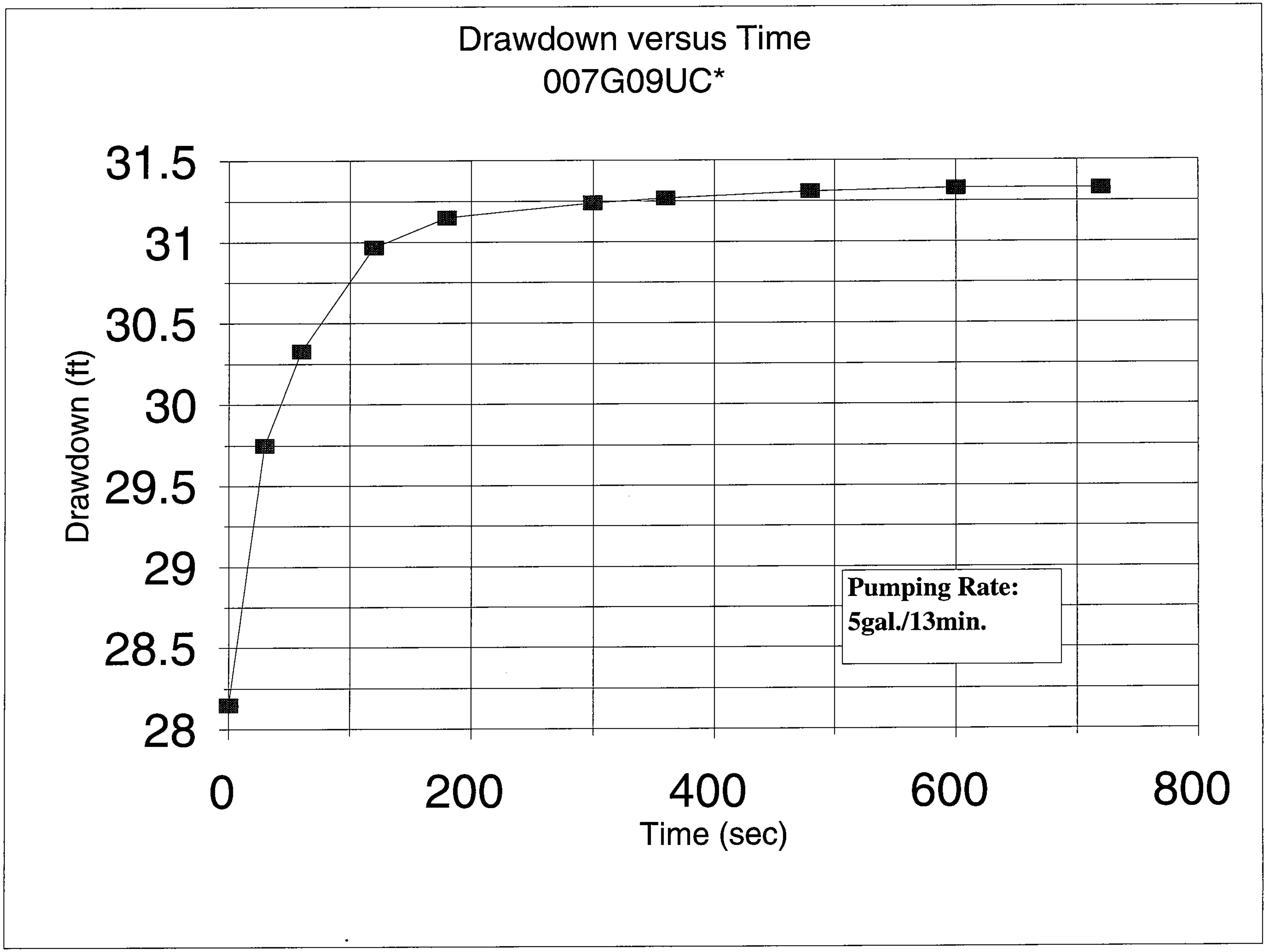

Drawdown versus Time
007G05UC*
Drawdown (ft)
30
29.5
29
28.5
28
27.5
27
26.5
0
200
400
600
800
1000
Time (sec)
Pumping Rate:
5gal./8min.

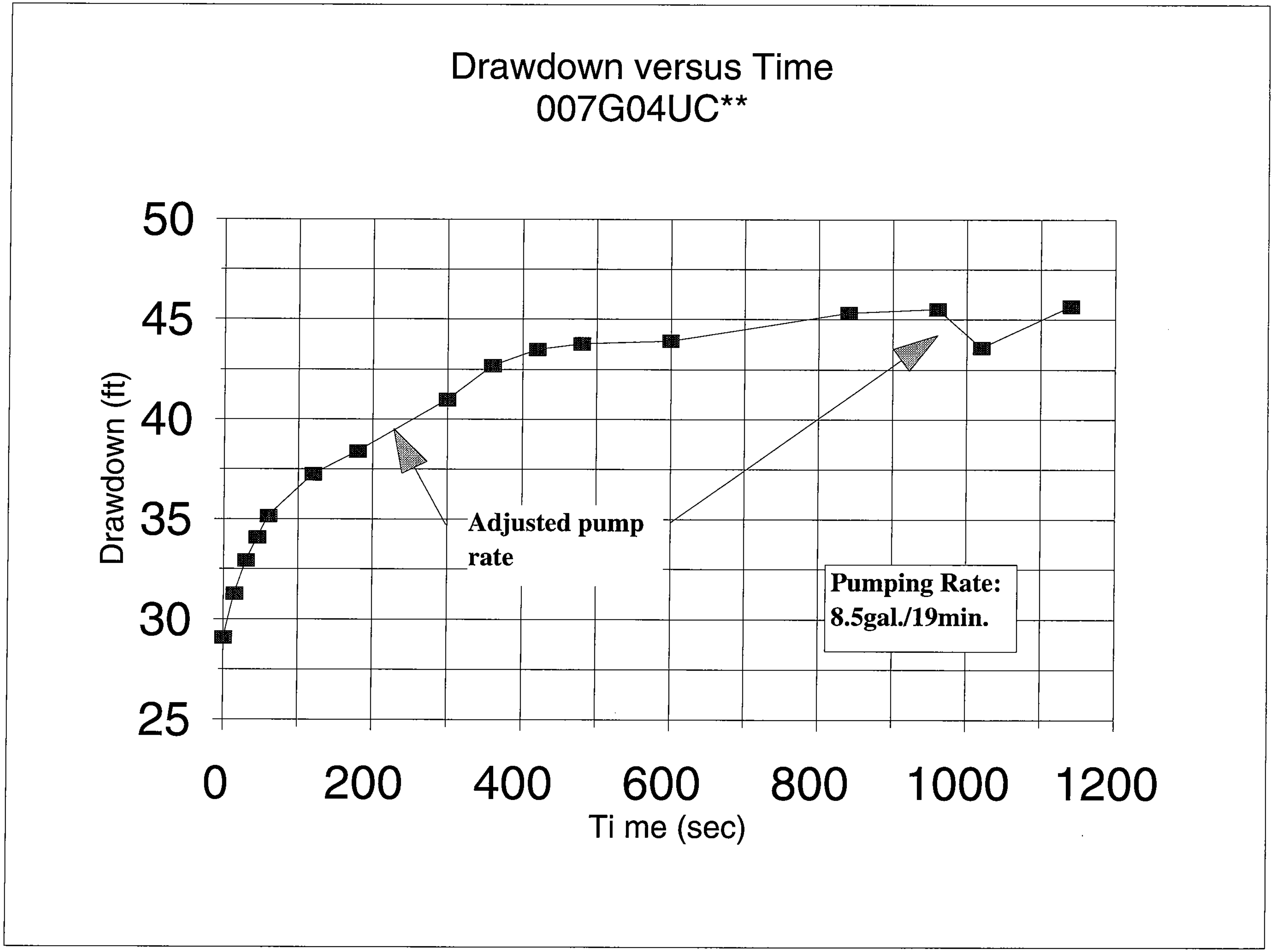

Drawdown versus Time
007G05UC
29
28.5
28
27.5
27
26.5
26
Darwdown (ft)
0
50
100
150
200
250
Time (sec)
Pumping Rate:
1gal./5min.

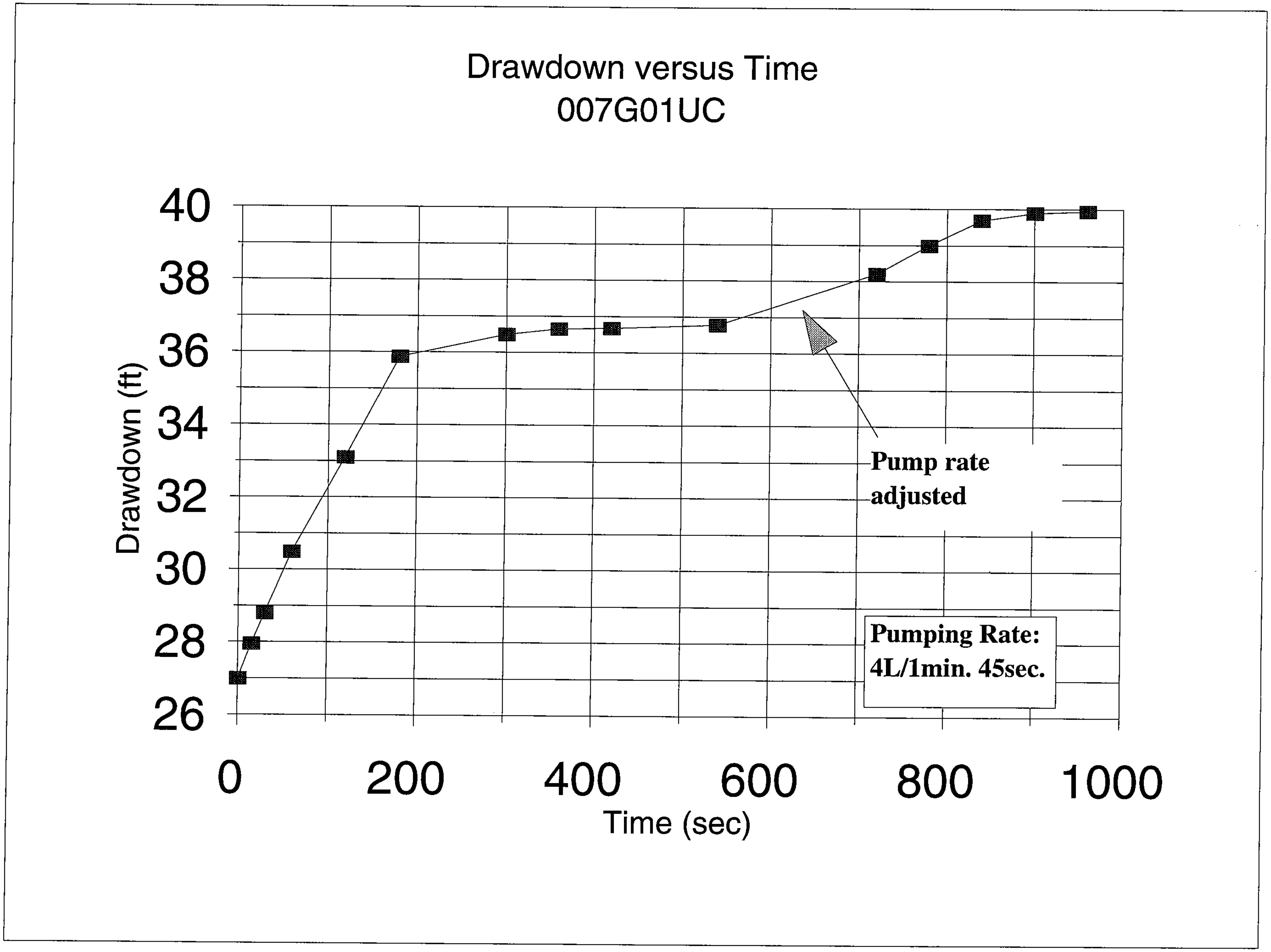

Drawdown versus Time
007G09UC***
Drawdown (ft)
60
55
50
45
40
35
30
25
0
50
100
150
200
250
300
Time (sec)
Pumping Rate:
2.5gal./min.

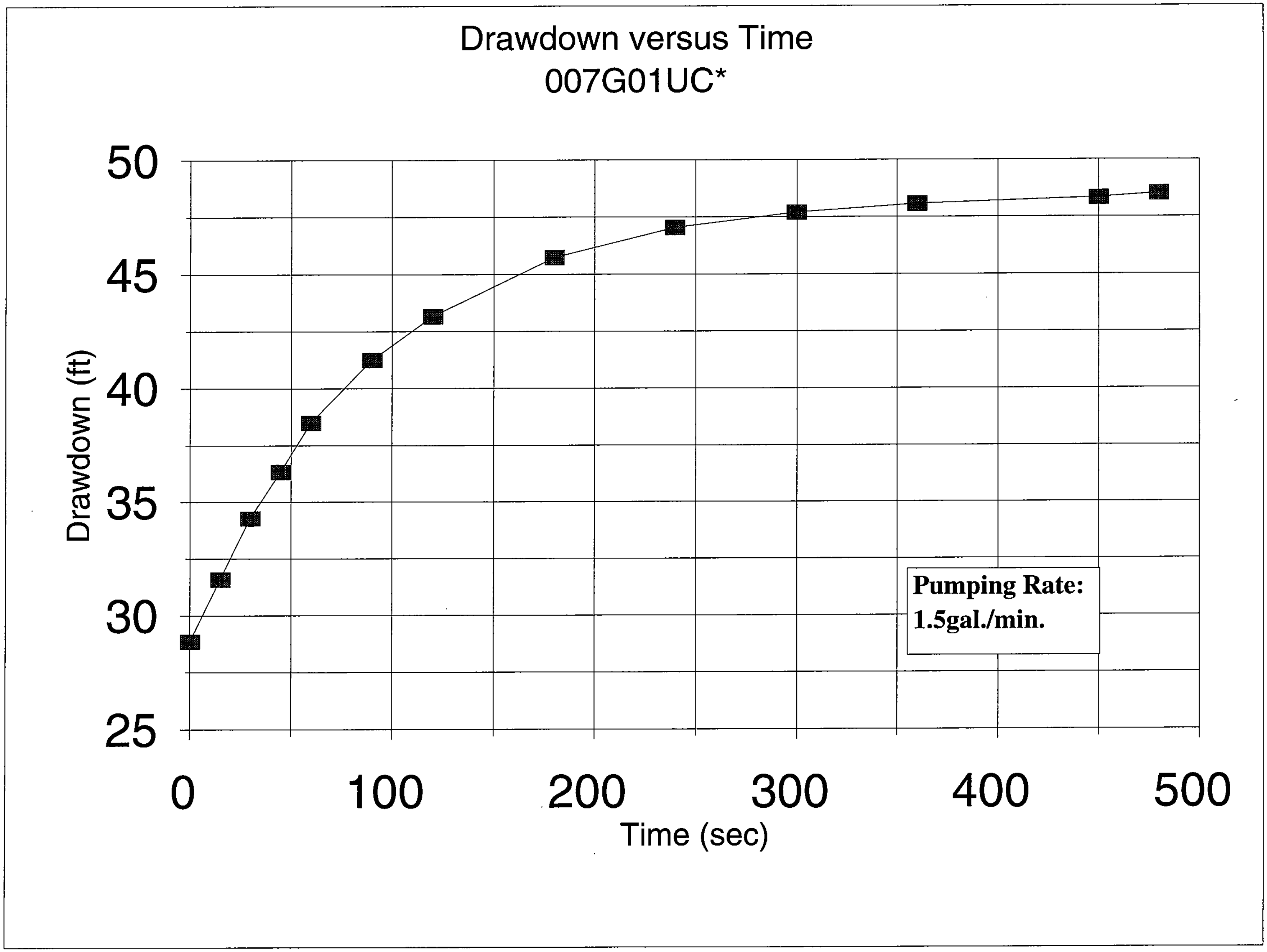


Drawdown versus Time
007G09UC**
36
34
32
30
28
26
24
Drawdown (ft)
0
100
200
300
400
500
Time (sec)
Pumping Rate:
5gal./7min.

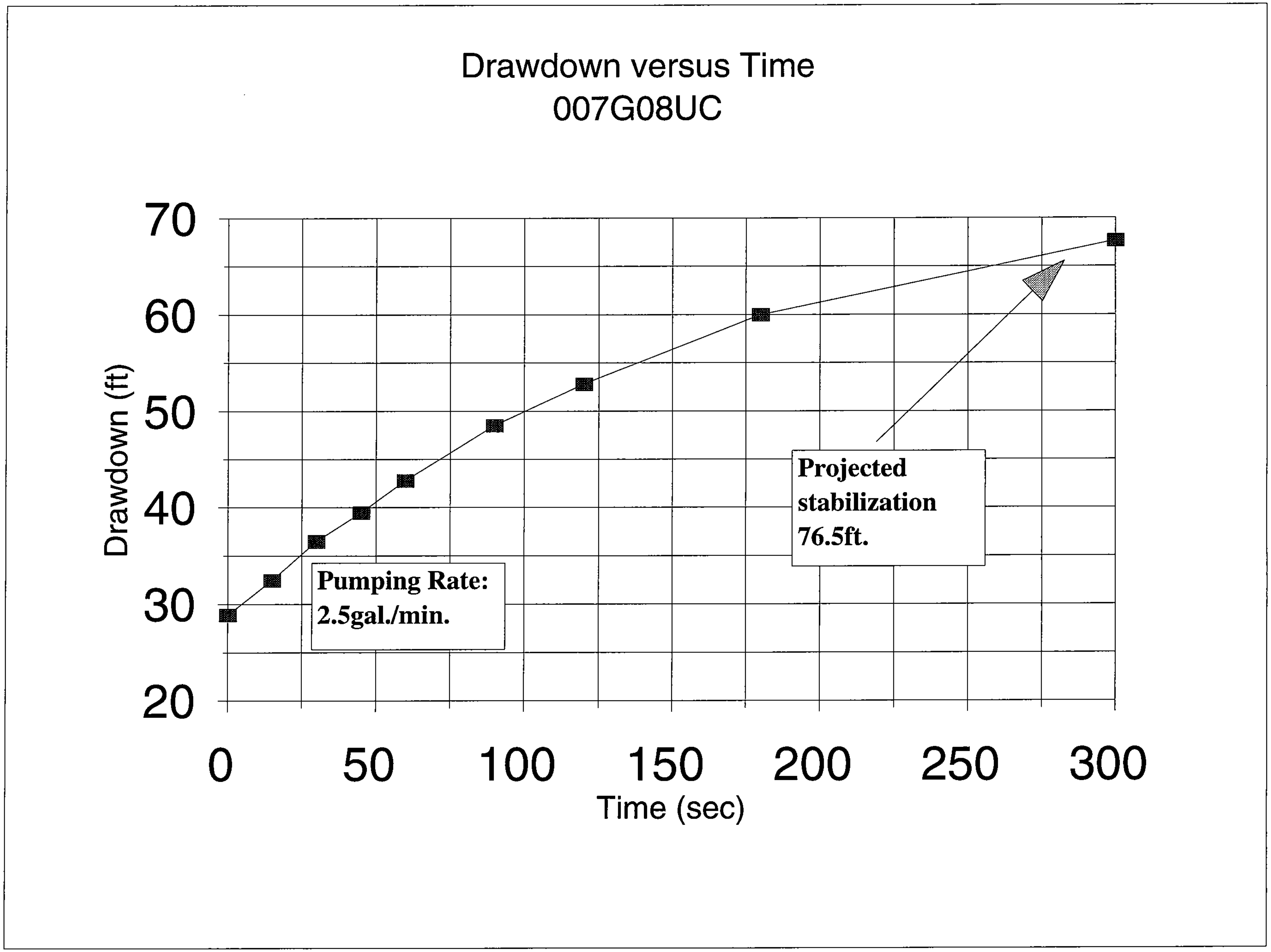

Drawdown versus Time
007G09UC*
31.5
31
30.5
30
29.5
29
28.5
28
Drawdown (ft)
0
200
400
600
800
Time (sec)
Pumping Rate:
5gal./13min.


Drawdown versus Time
007G04UC**
50
45
40
35
30
25
Drawdown (ft)
0
200
400
600
800
1000
1200
Ti me (sec)
Adjusted pump rate
Pumping Rate: 8.5gal./19min.

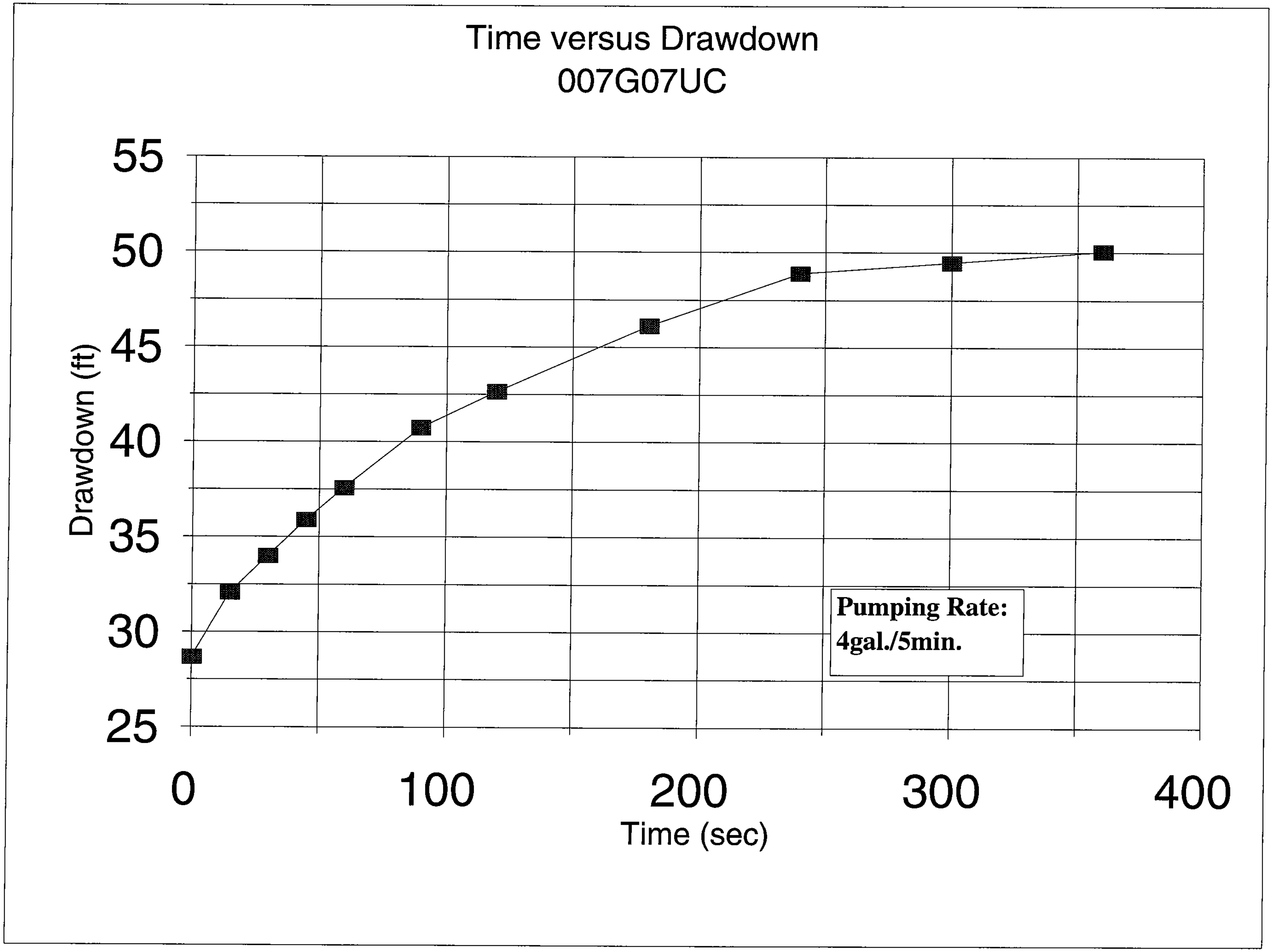

Drawdown versus Time
007G01UC
Drawdown (ft)
40
38
36
34
32
30
28
26
0
200
400
600
800
1000
Time (sec)
Pump rate adjusted
Pumping Rate:
4L/1min. 45sec.



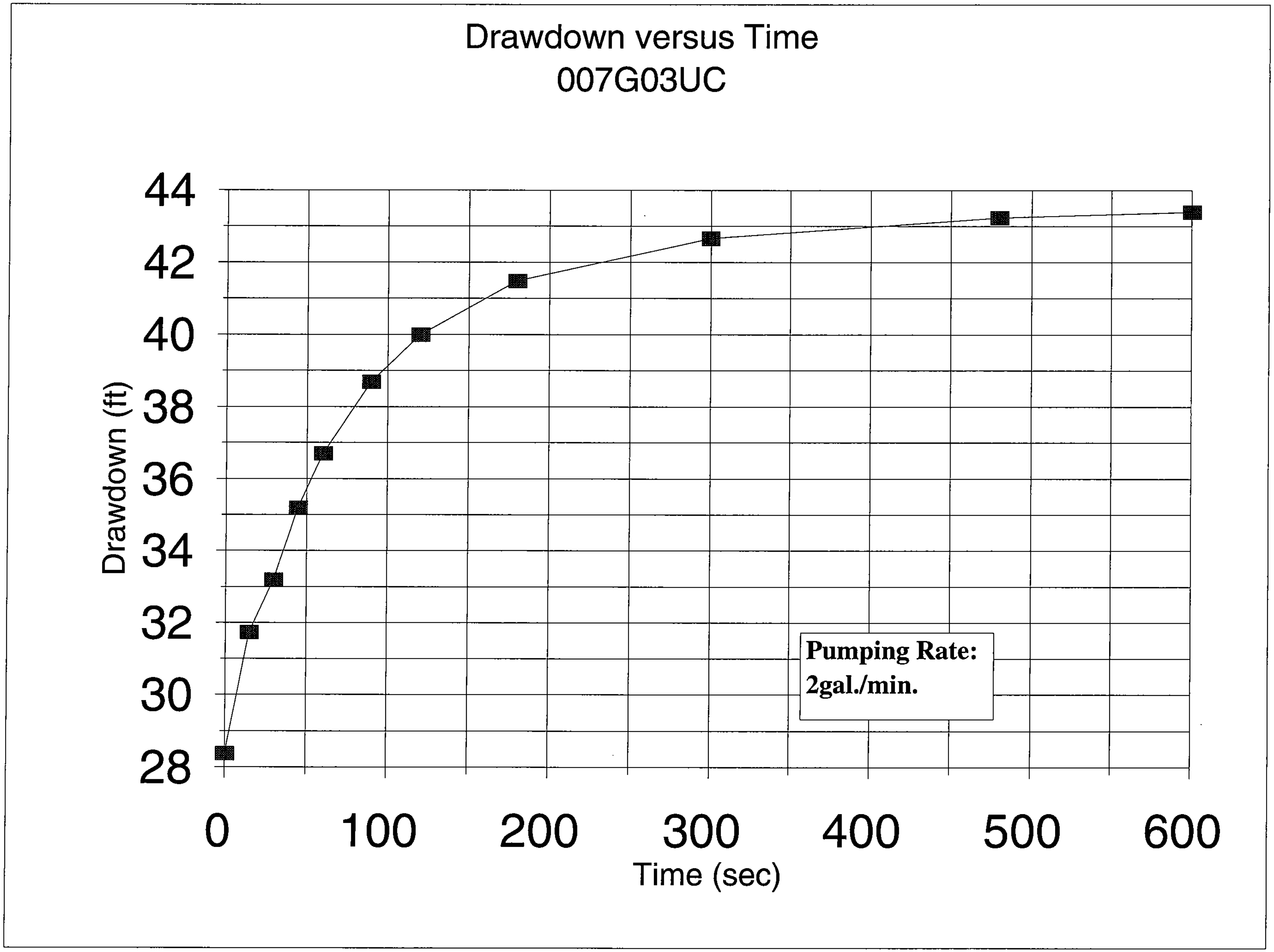
Drawdown versus Time
007G01UC*
50
45
40
35
30
25
Drawdown (ft)
0
100
200
300
400
500
Time (sec)
Pumping Rate:
1.5gal./min.



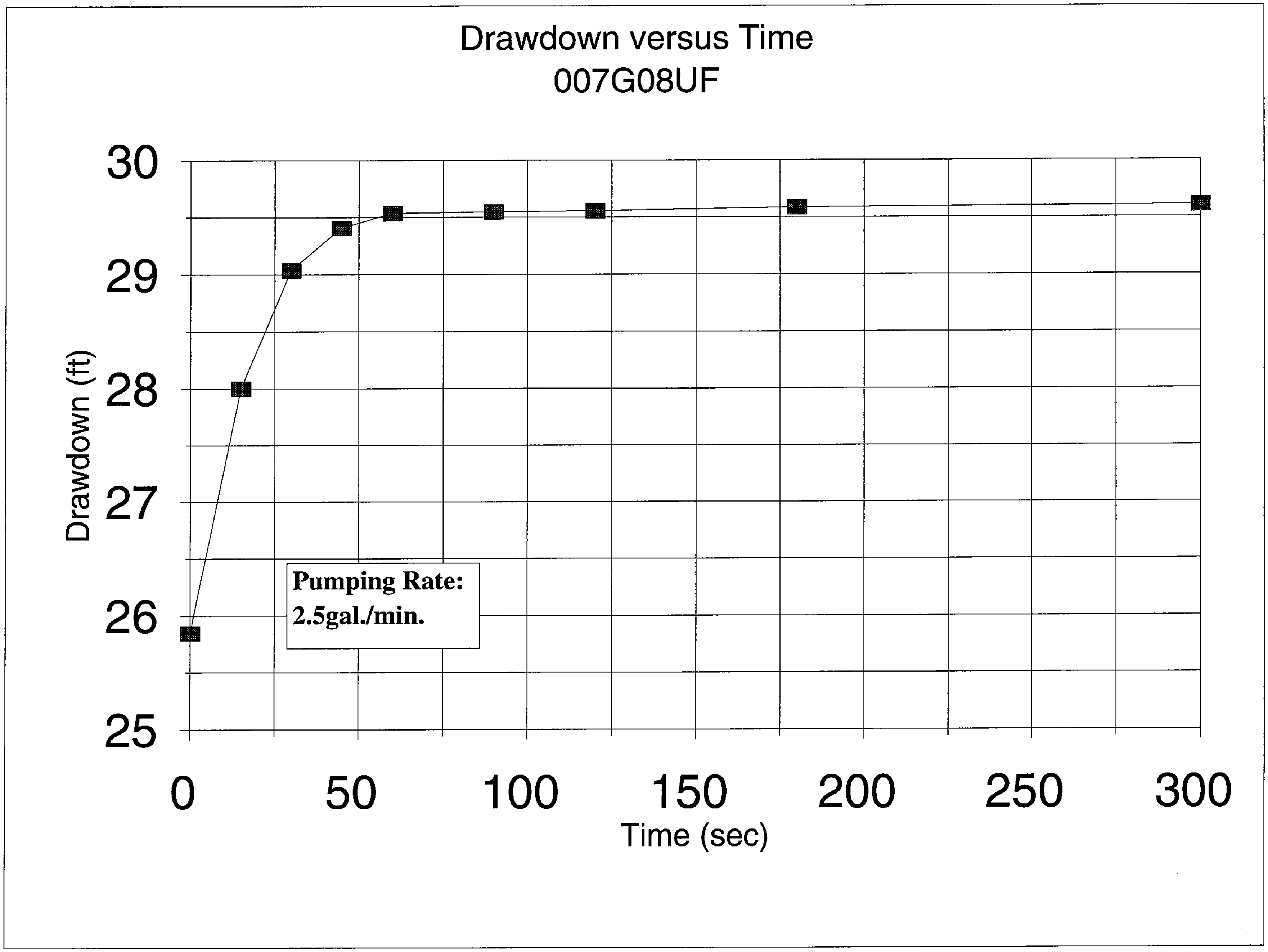
Drawdown versus Time
007G08UC
70
60
50
40
30
20
Drawdown (ft)
0
50
100
150
200
250
300
Time (sec)
Pumping Rate:
2.5gal./min.
Projected
stabilization
76.5ft.

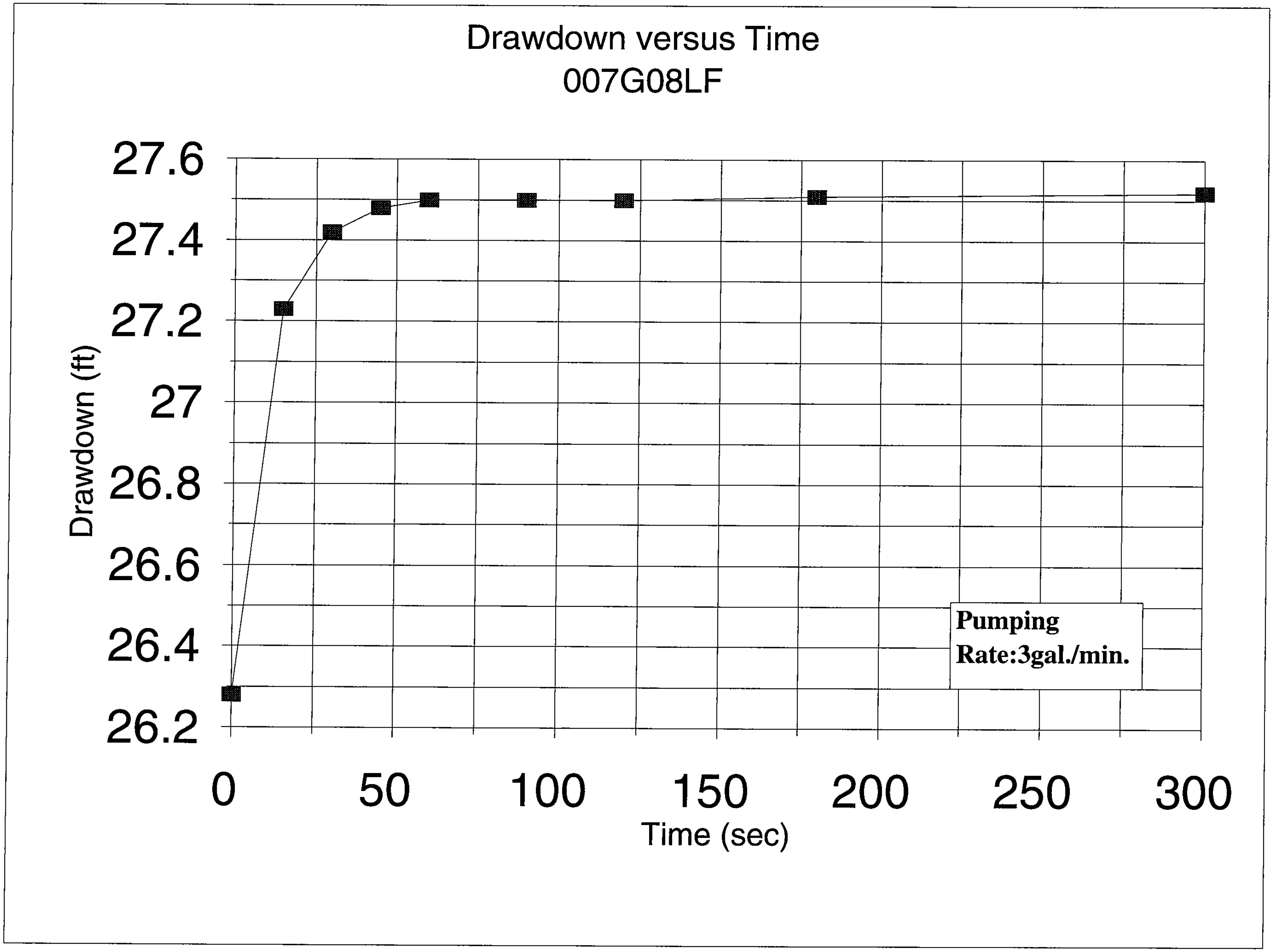


Time versus Drawdown
007G07UC
Drawdown (ft)
55
50
45
40
35
30
25
0
100
200
300
400
Time (sec)
Pumping Rate:
4gal./5min.

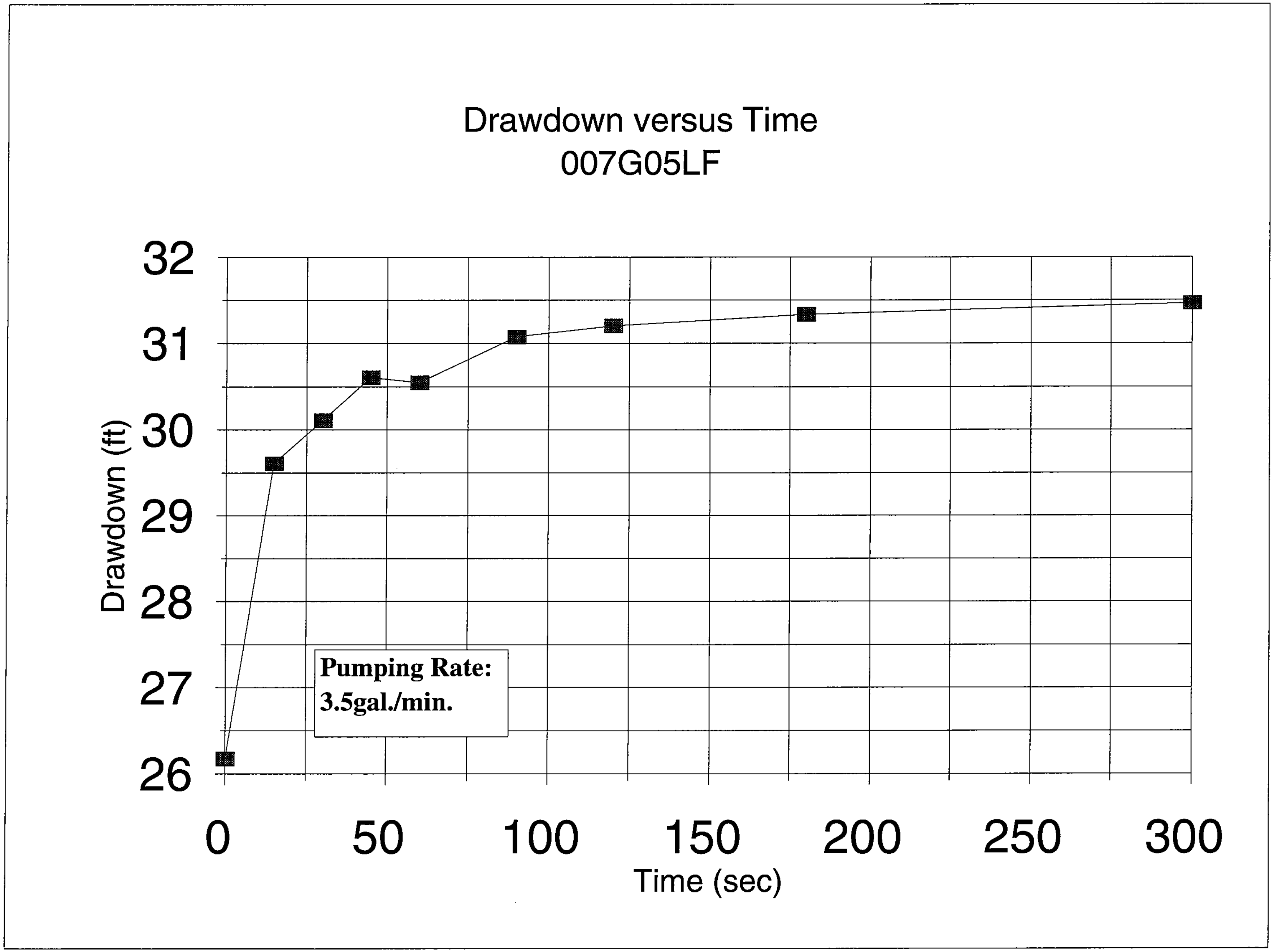


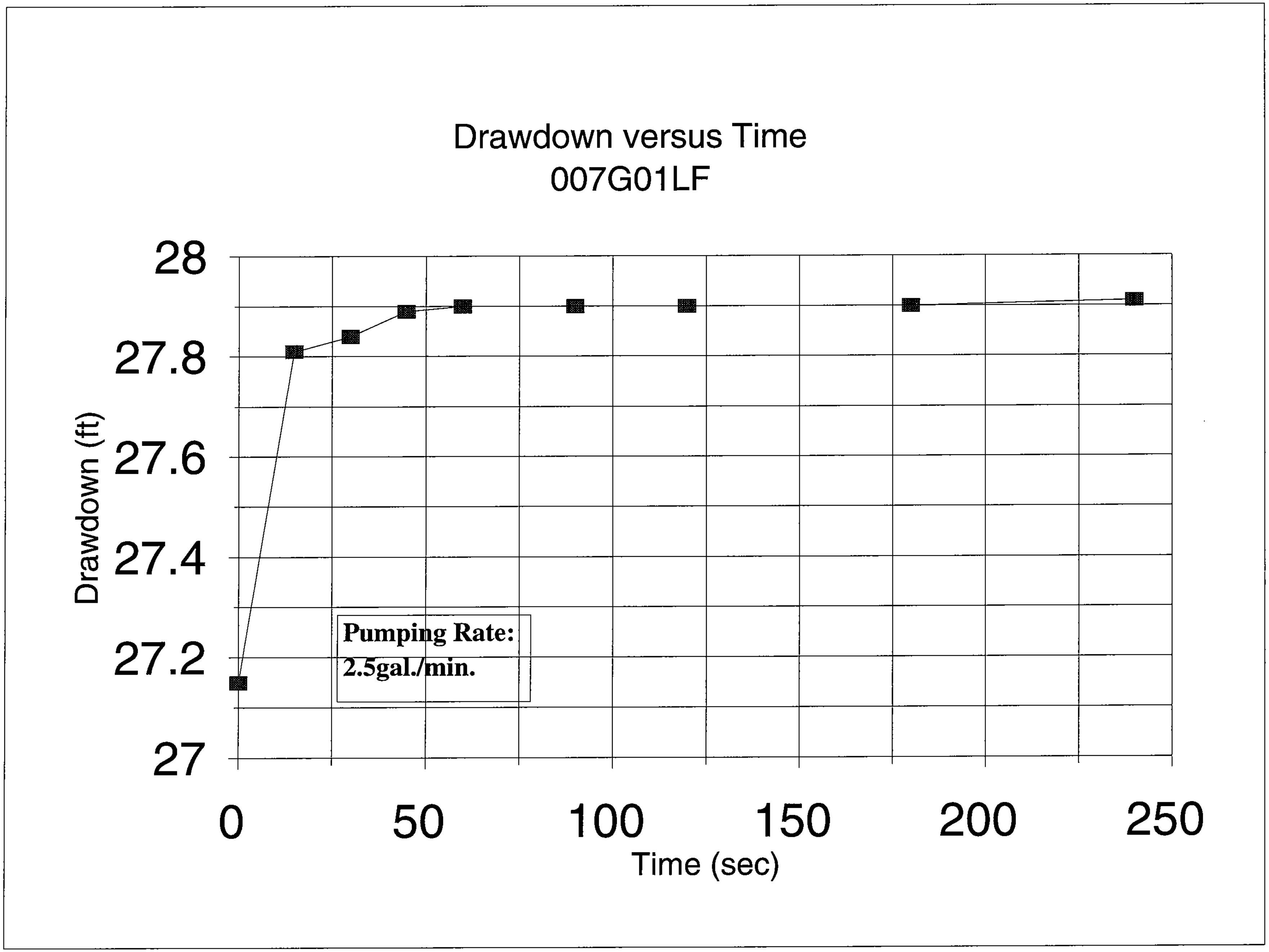
Drawdown versus Time
007G03UC
Drawdown (ft)
44
42
40
38
36
34
32
30
28
0
100
200
300
400
500
600
Time (sec)
Pumping Rate:
2gal./min.


Drawdown versus Time
007G08UF
30
29
28
27
26
25
Drawdown (ft)
0
50
100
150
200
250
300
Time (sec)
Pumping Rate:
2.5gal./min.



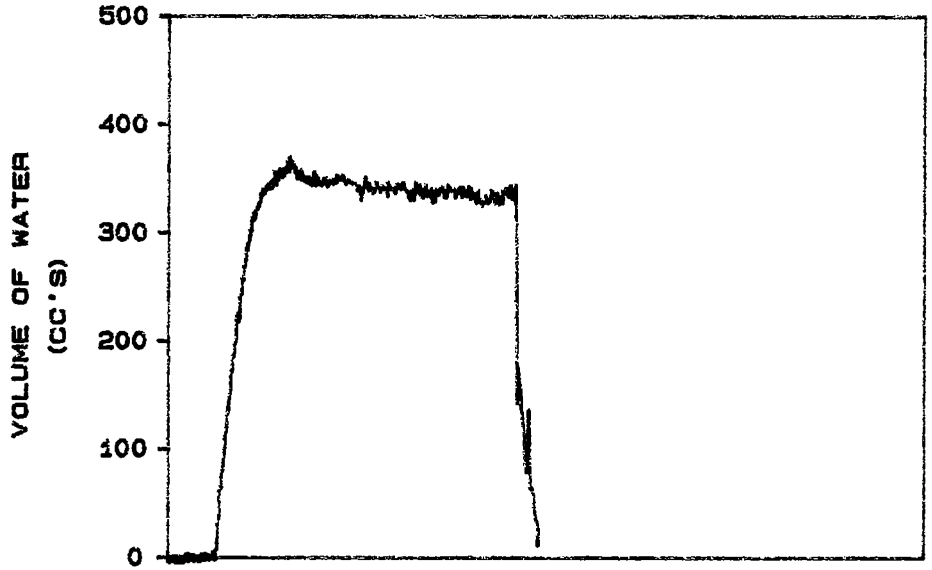
Drawdown versus Time
007G08LF
Drawdown (ft)
27.6
27.4
27.2
27
26.8
26.6
26.4
26.2
0
50
100
150
200
250
300
Time (sec)
Pumping
Rate:3gal./min.

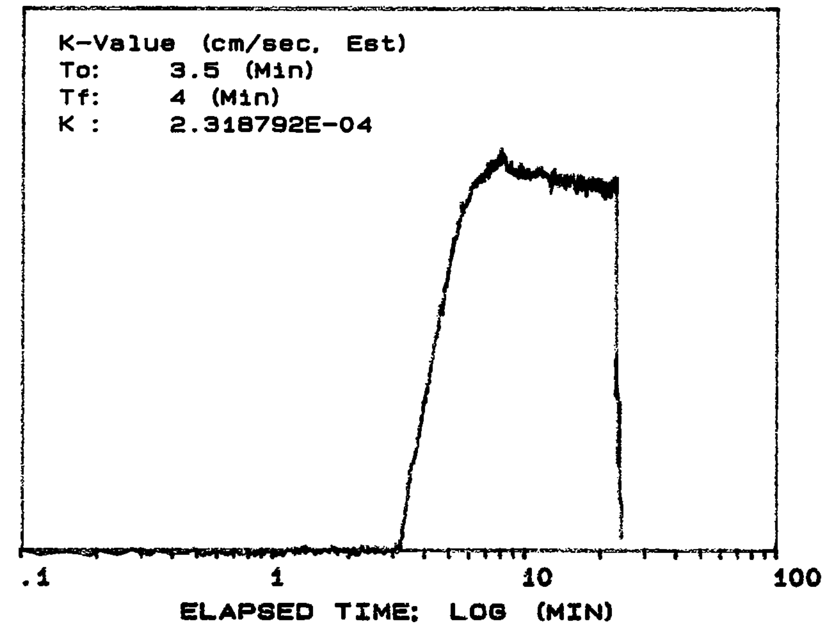

Drawdown versus Time
007G05LF
Drawdown (ft)
32
31
30
29
28
27
26
Pumping Rate:
3.5gal./min.
0
50
100
150
200
250
300
Time (sec)

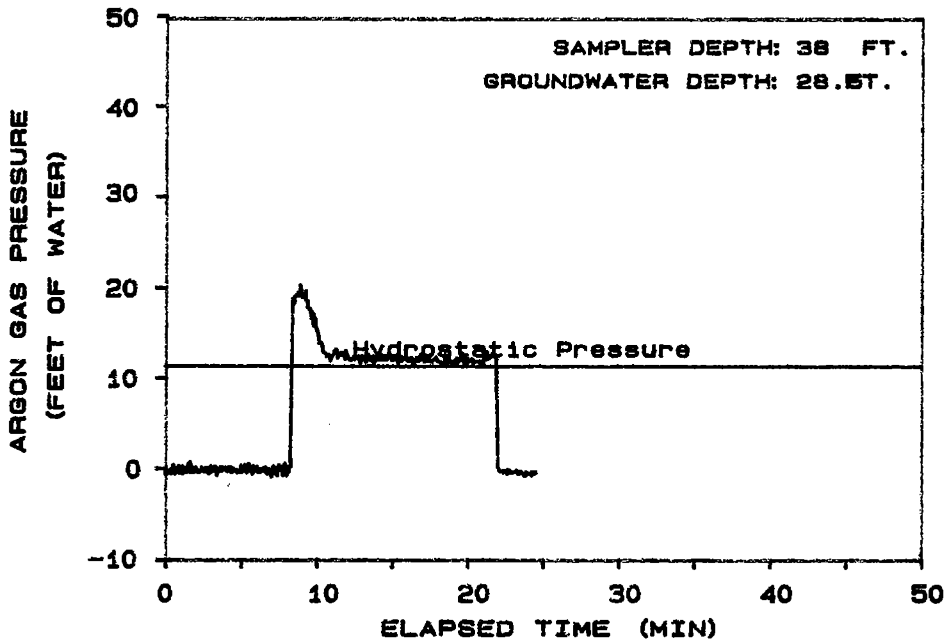

Drawdown versus Time
007G01LF
Drawdown (ft)
28
27.8
27.6
27.4
27.2
27
0
50
100
150
200
250
Time (sec)
Pumping Rate:
2.5gal./min.

Hydrocone Data

Apron Area Hydrocone Data — Hydraulic Conductivity			
Sample Location	**Estimated hydraulic conductivity (K) value (feet/day)**	**Sampler Depth or Screened Interval (ft.)**	**Groundwater Depth (ft.)**
07GH3336	0.29	35-36	18
07GH3245	0.03	44-45	18
07GH3145	0.12	44-45	18
07GH3047	0.03	46-47	18
07GH2936	0.053	35-36	18
07GH2745	0.18	44-45	18
07GH2644	0.044	43-44	18
07GH2544	0.12	43-44	18
07GH2437	0.36	36-37	18
7GH2343	0.36	43	28.5
7GH2243	0.45	43	28.5
7GH2136	0.38	36	28.5
7GH2038	0.33	38	28.5
7GH1942	1.97	42	28.5
7GH1841	0.37	41	28.5
7GH1741	0.051	41	28.5
7GH1636	0.25	36	28.5
7GH1542	2.27	42	28.5
7GH1442	0.22	42	28.5
7GH1339	2.23	39	28.5
7GH1143	0.0043	43	28.5
7GH1039	0.066	38	28.5
7GH0940	0.046	40	28.5
7GH0836	0.15	36	28.5
7GH0636	0.31	36	28.5
7GH0535B	0.02	36	28.5
7GH0435	0.18	35	28.5
7GH0236	0.29	36	28.5
7GH0138	0.66	38	28.5
	Mean 0.41		







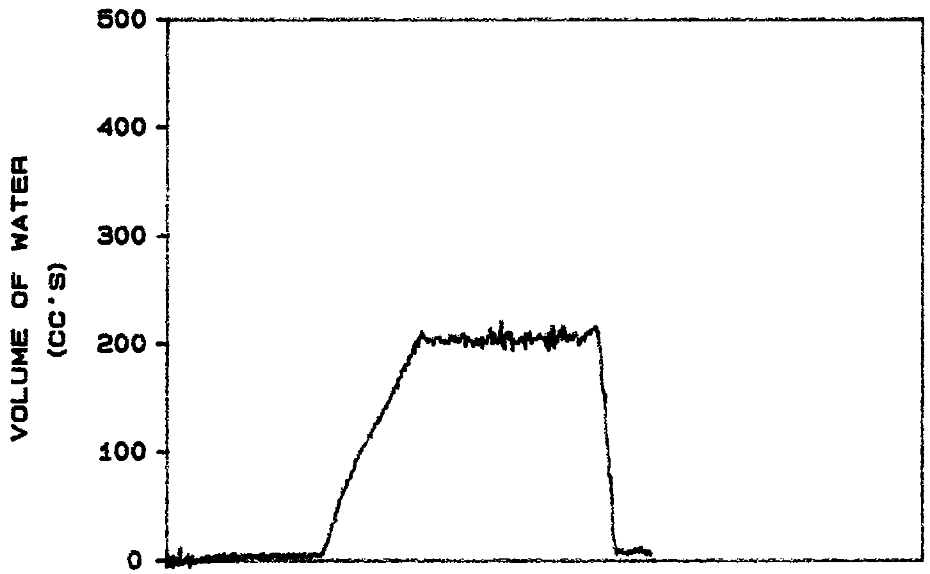
GS-1 SAMPLE PLOT

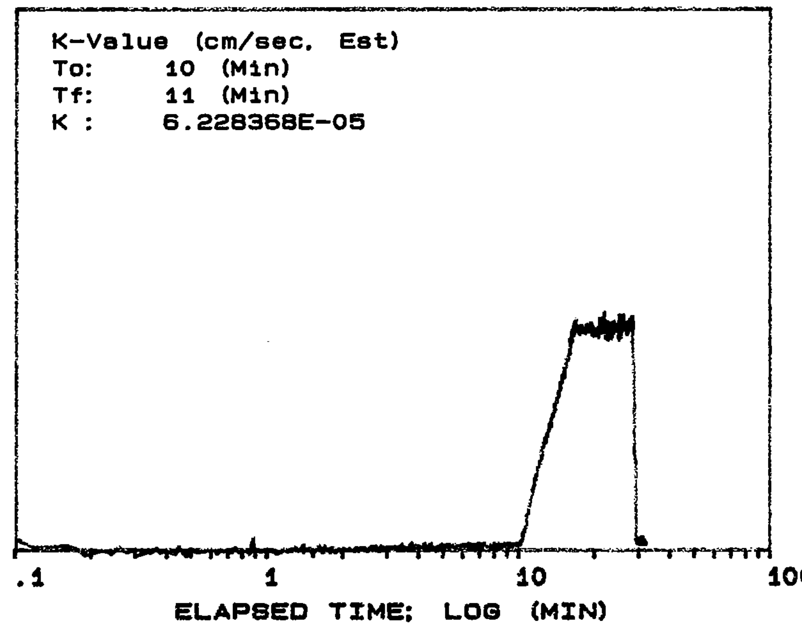
SAMPLE #: 7GH0138

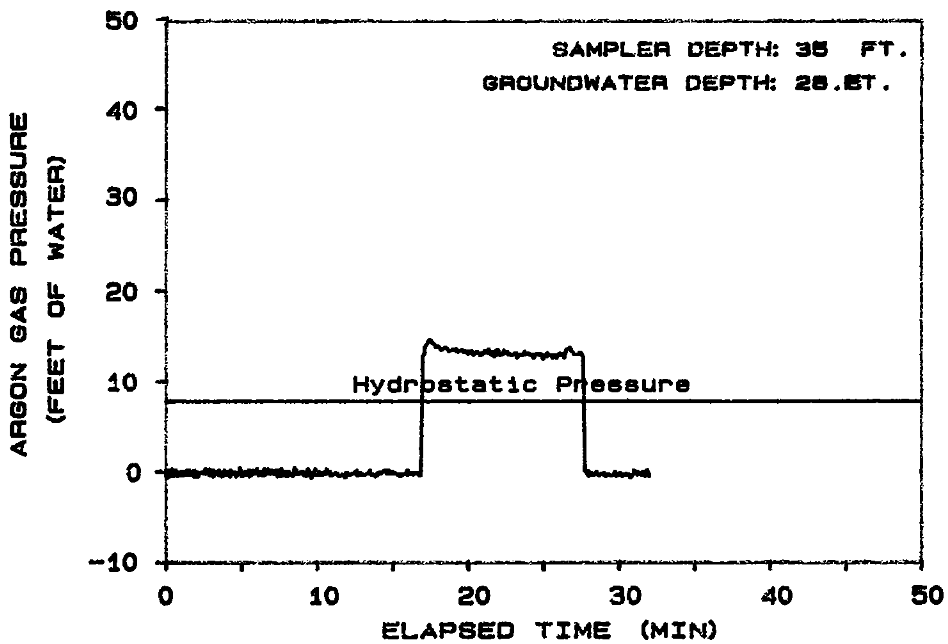
CLIENT: ENSAFE	JOB: NASM094
DATE: 11-21-1994	LOCATION: SWMU7 ST1

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

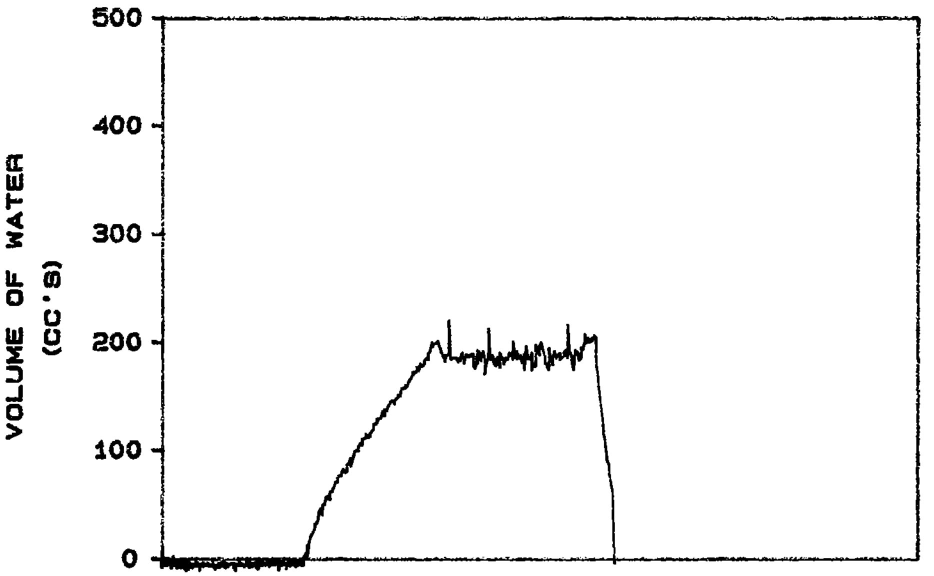
SAMPLE #: 7GH0435

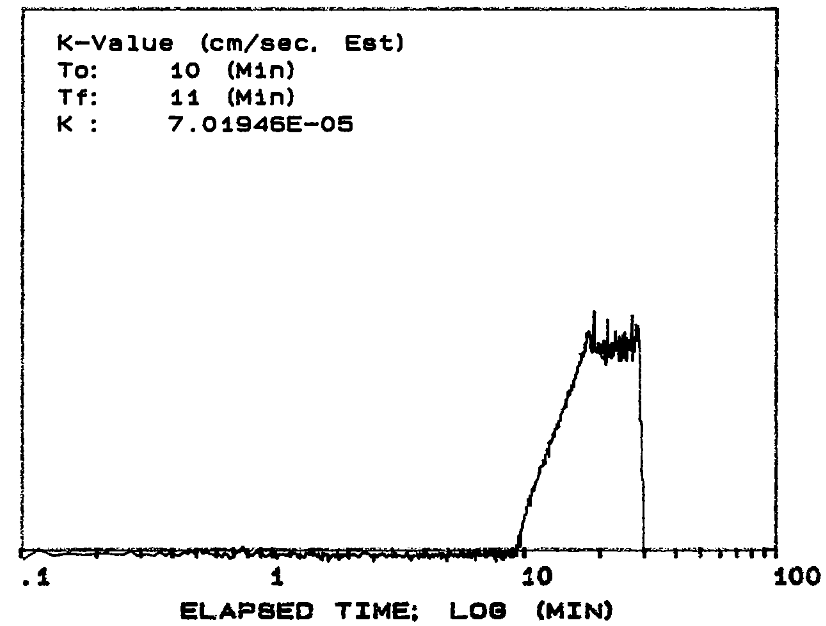
CLIENT: ENSAFE JOB: NASM094

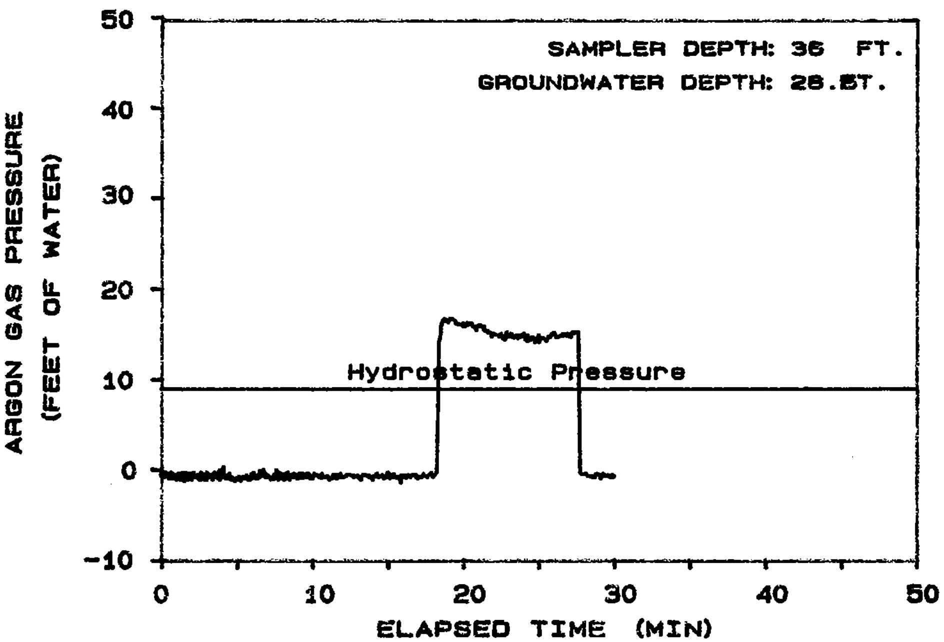
DATE: 11-22-1994 LOCATION: SWMU7 ST4

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

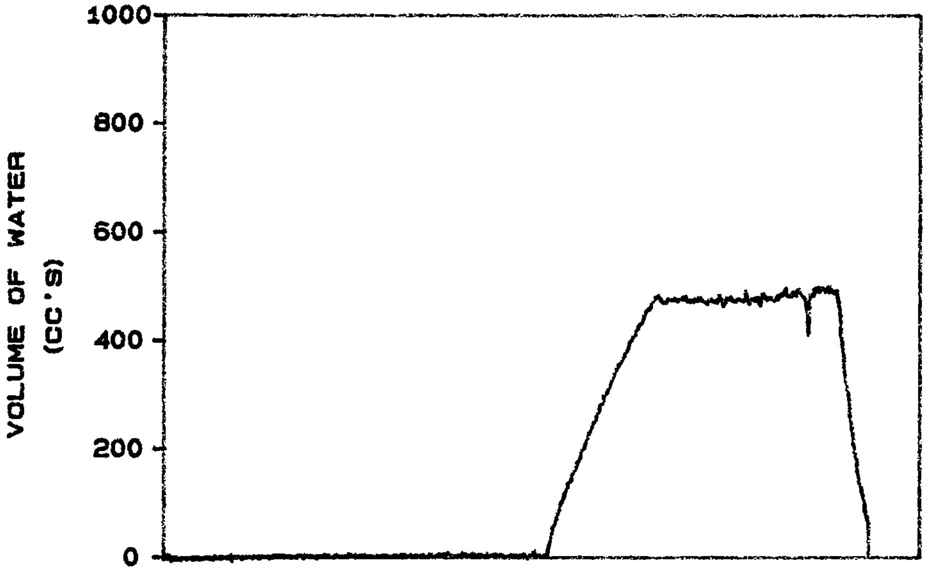
SAMPLE #: 7GH0535B

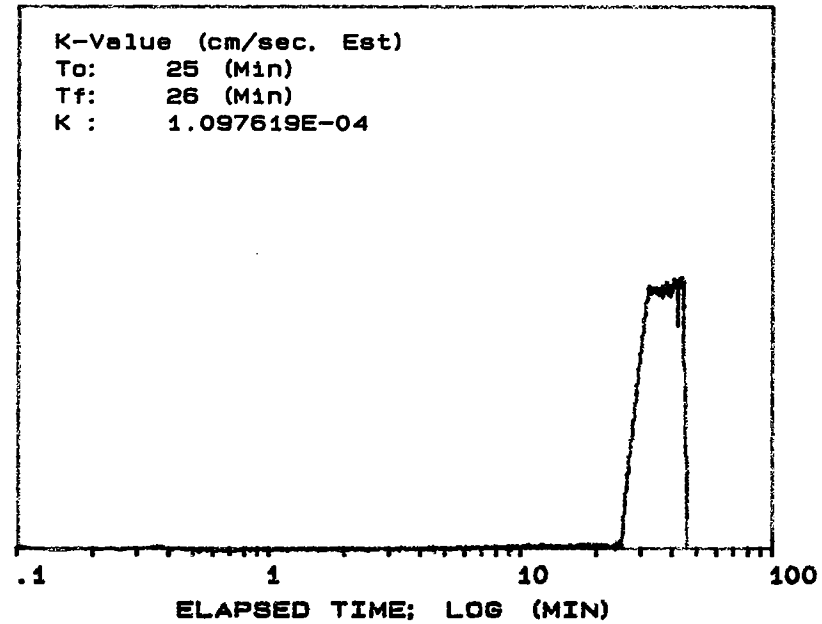
CLIENT: ENSAFE JOB: NASM094

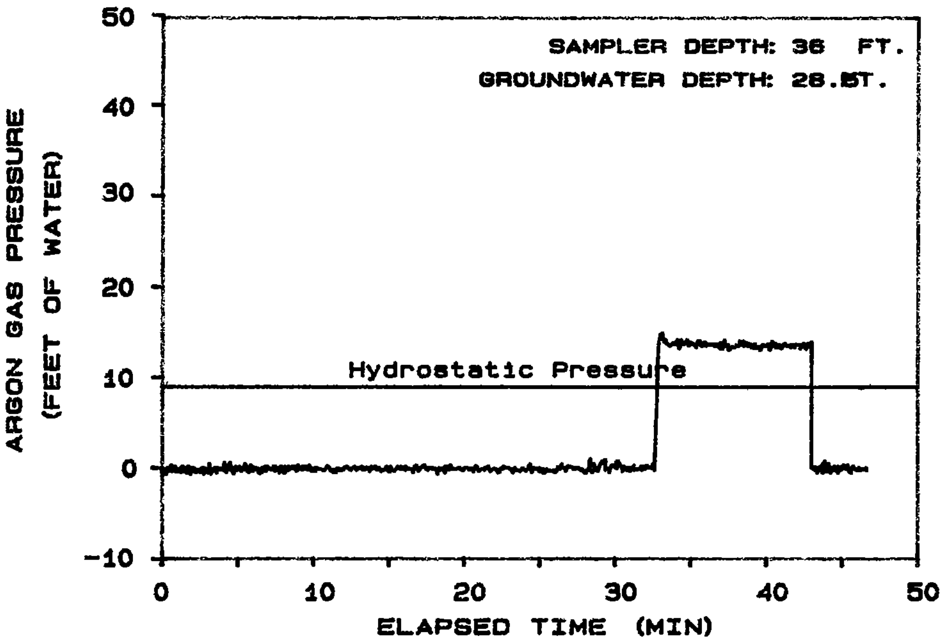
DATE: 11-22-1994 LOCATION: SWMU7 ST5

PERFORMED BY:

SUBSURFACE TECHNOLOGY







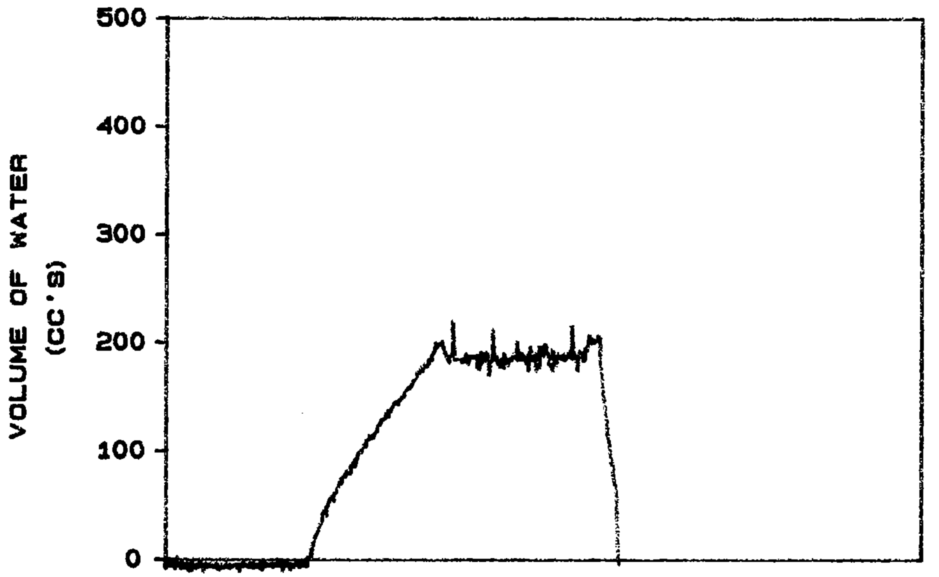
GS-1 SAMPLE PLOT

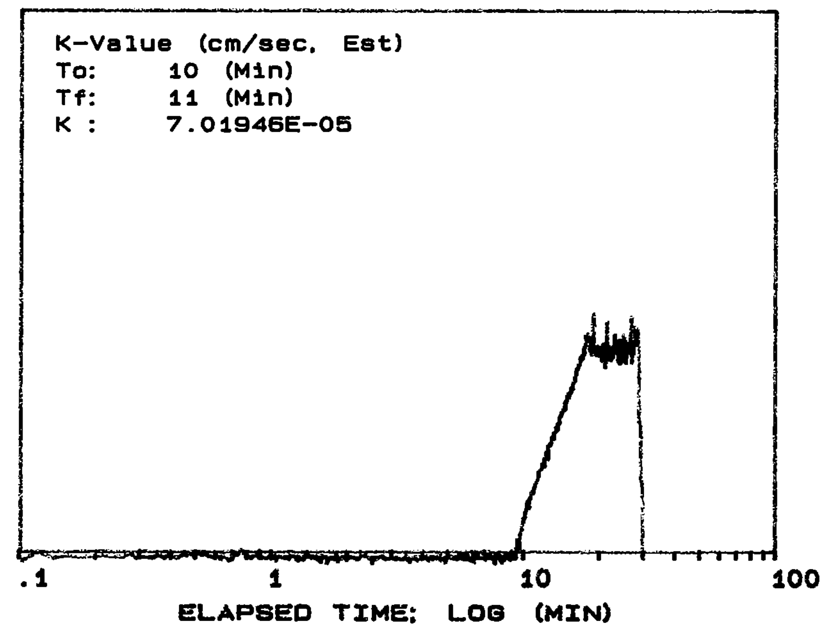
SAMPLE #: 7GH0636

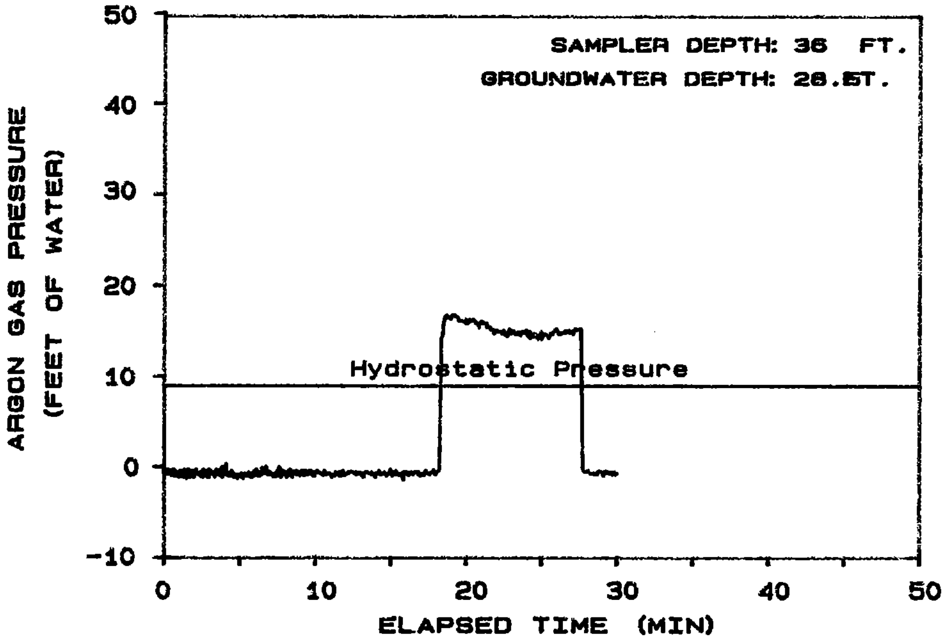
CLIENT:	ENSAFE	JOB:	NASM094
DATE:	11-22-1994	LOCATION:	SWMU7 ST6

PERFORMED BY:

SUBSURFACE TECHNOLOGY







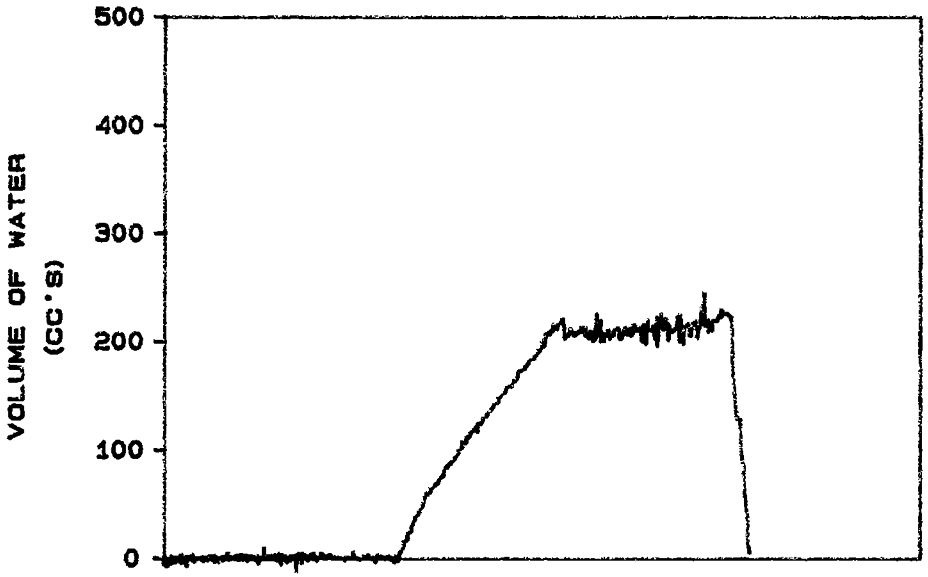
GS-1 SAMPLE PLOT

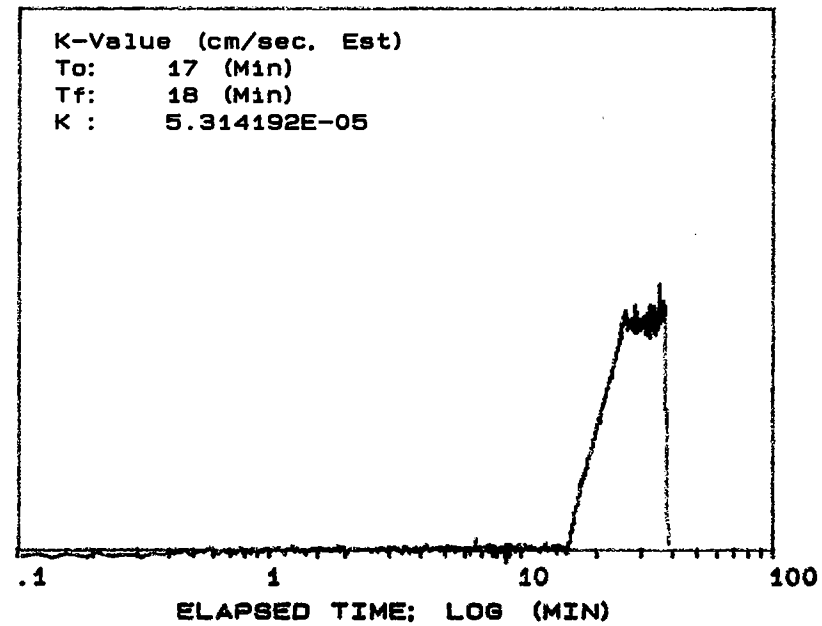
SAMPLE #: 7GH0535B

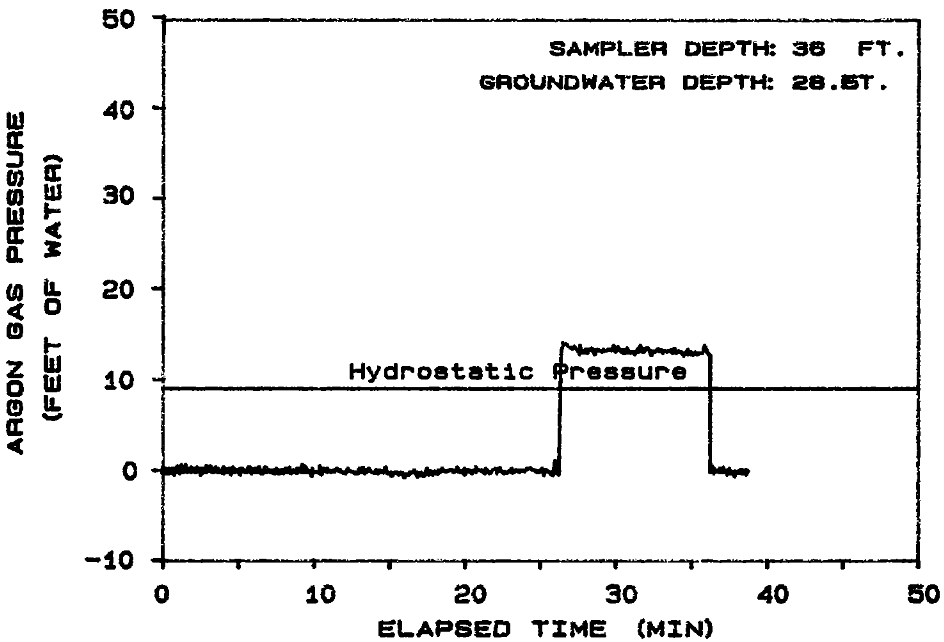
CLIENT:	ENSAFE	JOB:	NASM094
DATE:	11-22-1994	LOCATION:	SWMU7 ST5

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

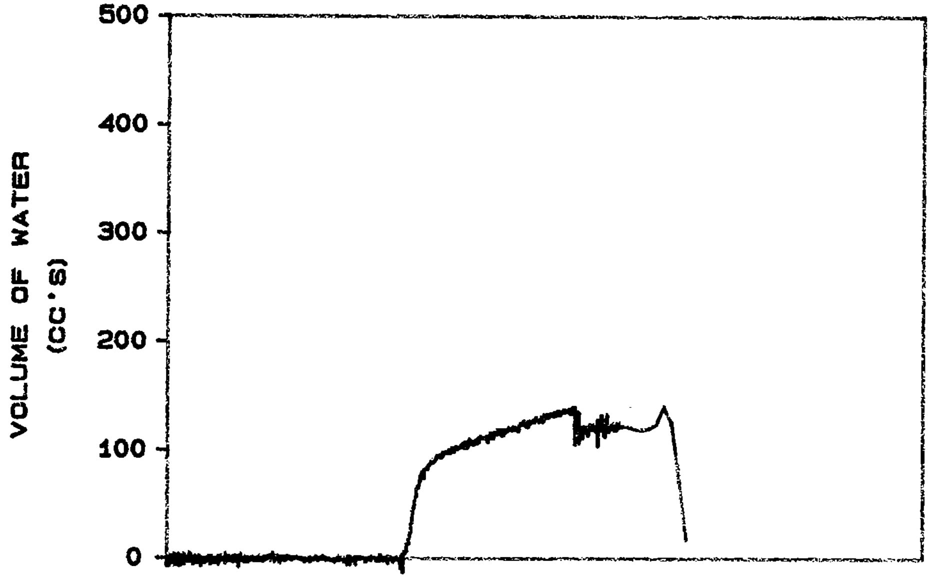
SAMPLE #: 7GH0836

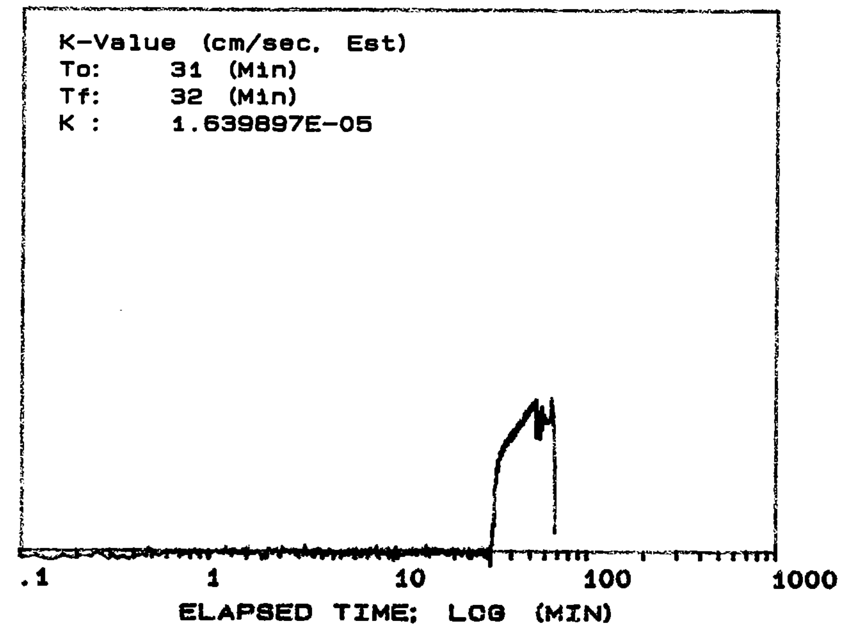
CLIENT: ENSAFE JOB: NASM094

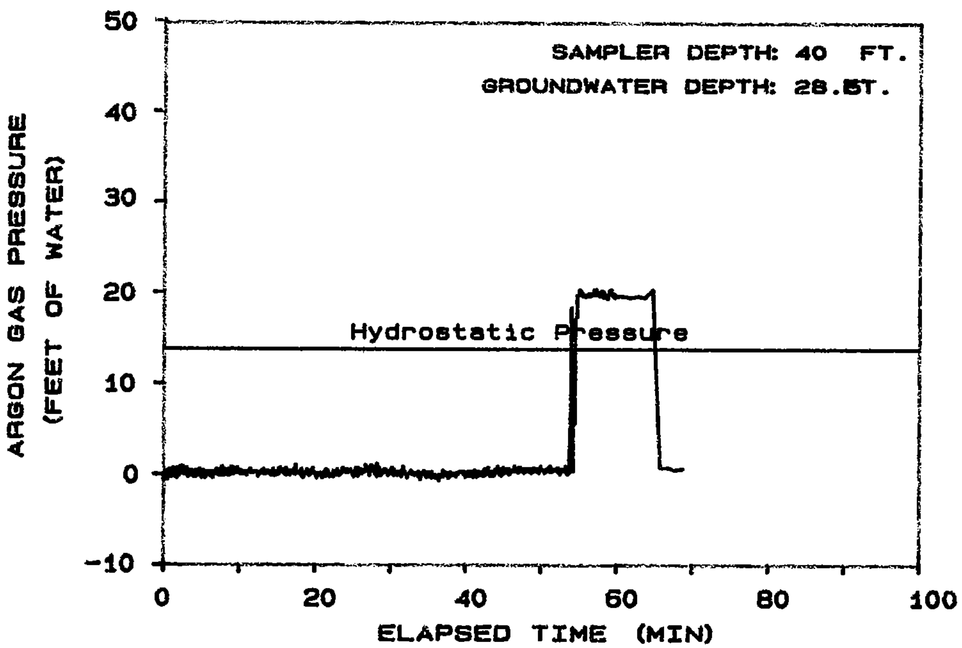
DATE: 11-28-1994 LOCATION: SWMU7 ST7

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

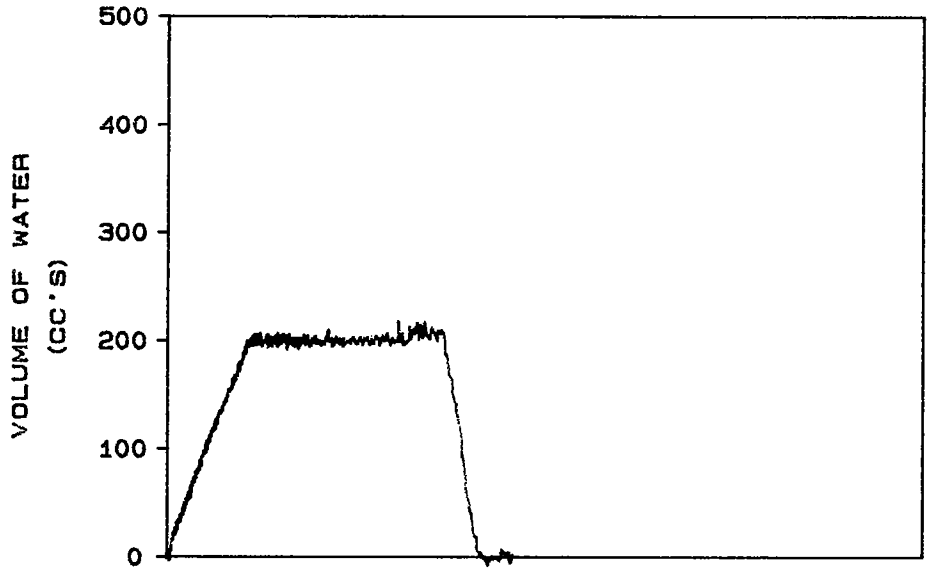
SAMPLE #: 7GH0940

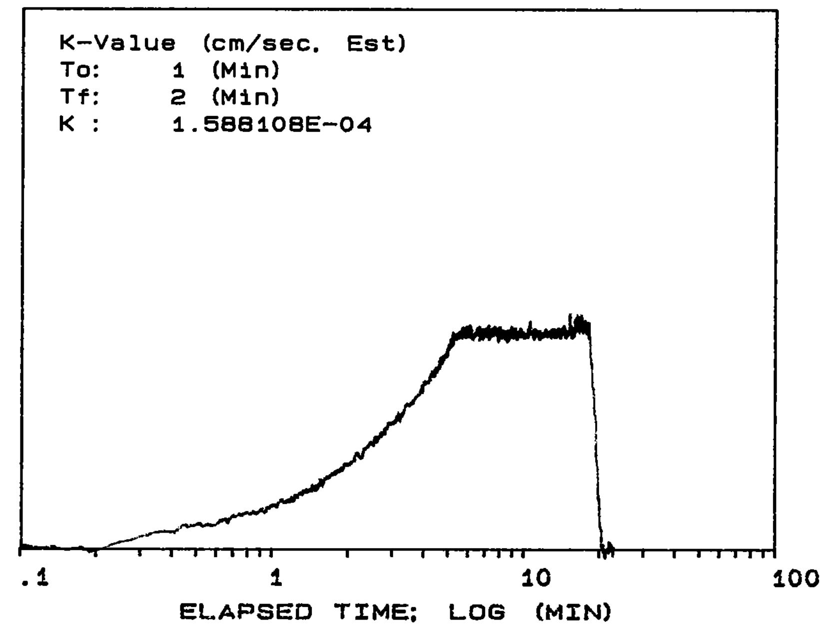
CLIENT: JOB:

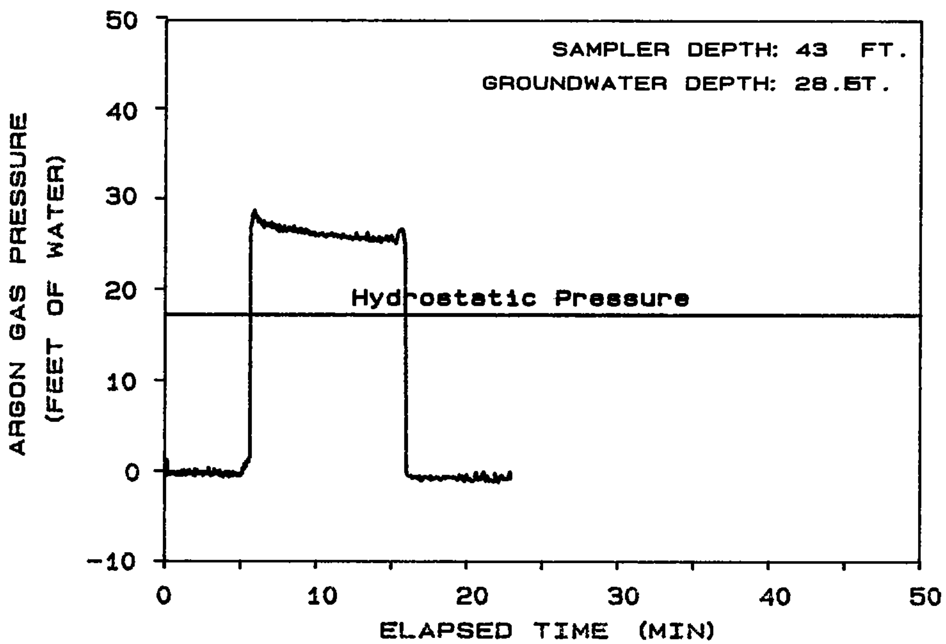
DATE: 03-10-1995 LOCATION:

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

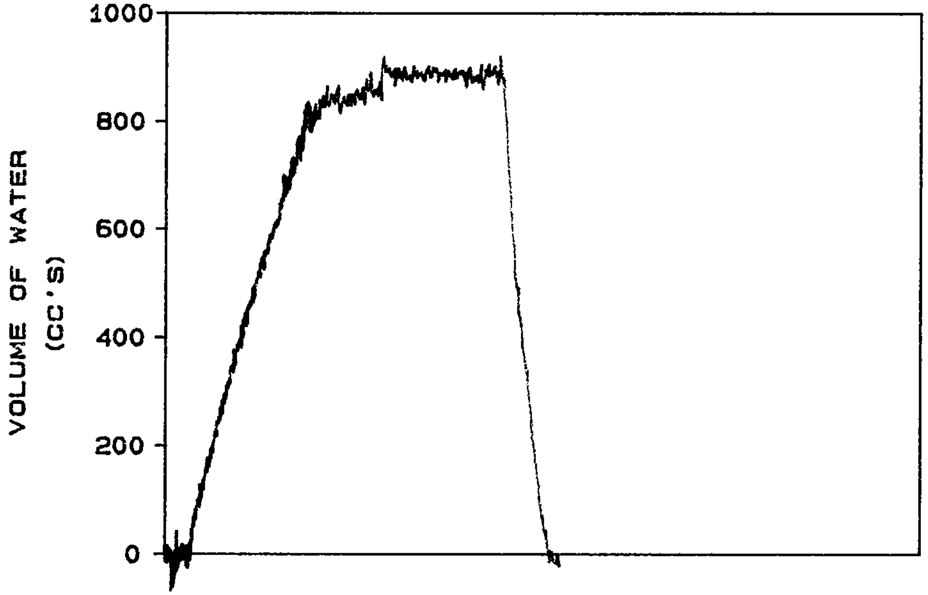
SAMPLE #: 7GH2243

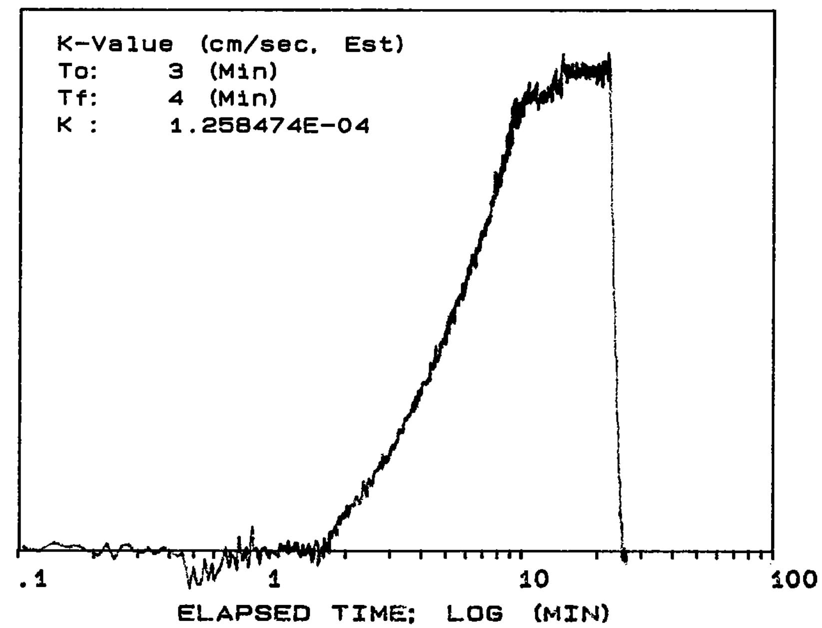
CLIENT: ENSAFE JOB: NASM094

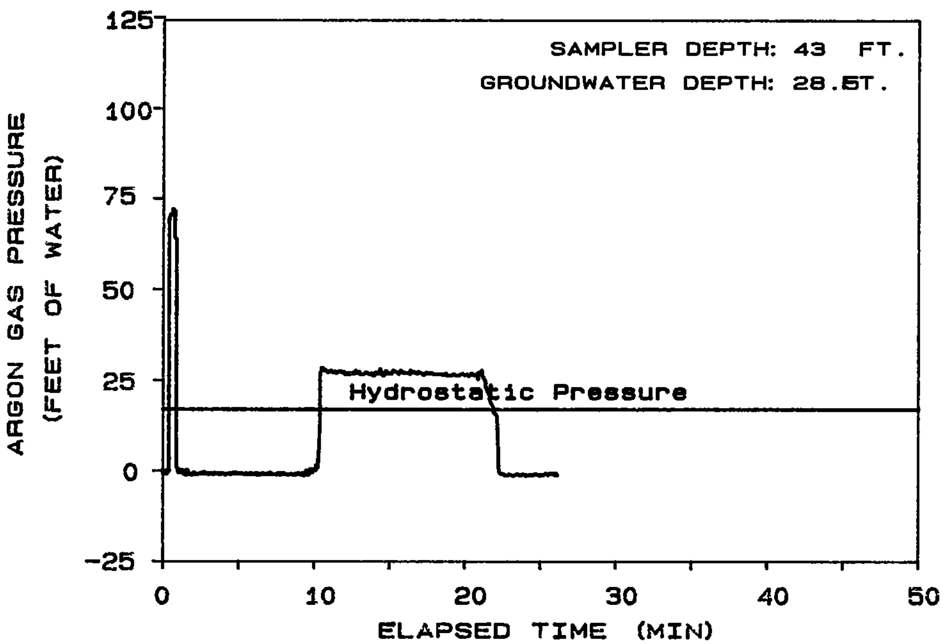
DATE: 12-10-1994 LOCATION: SWMU7 ST22

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

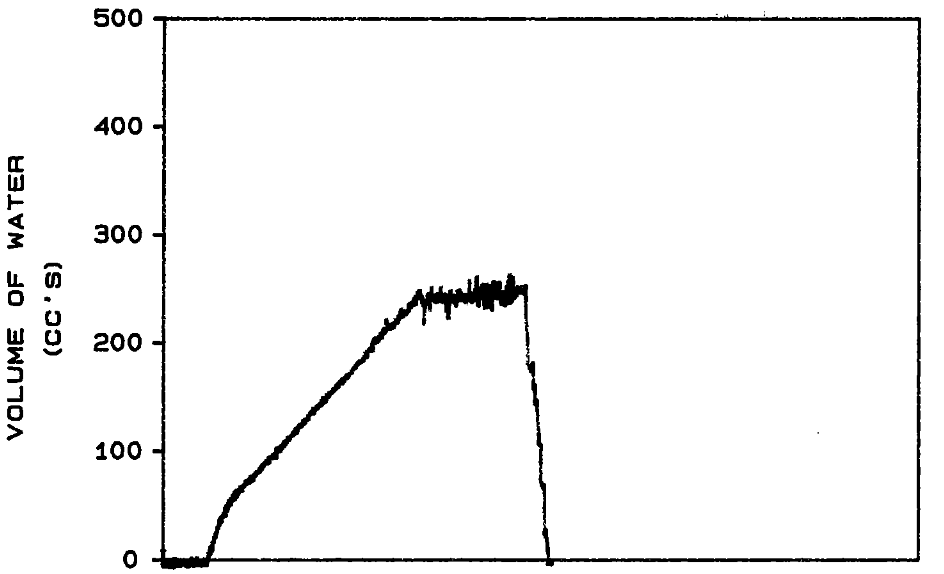
SAMPLE #: 7GH2343

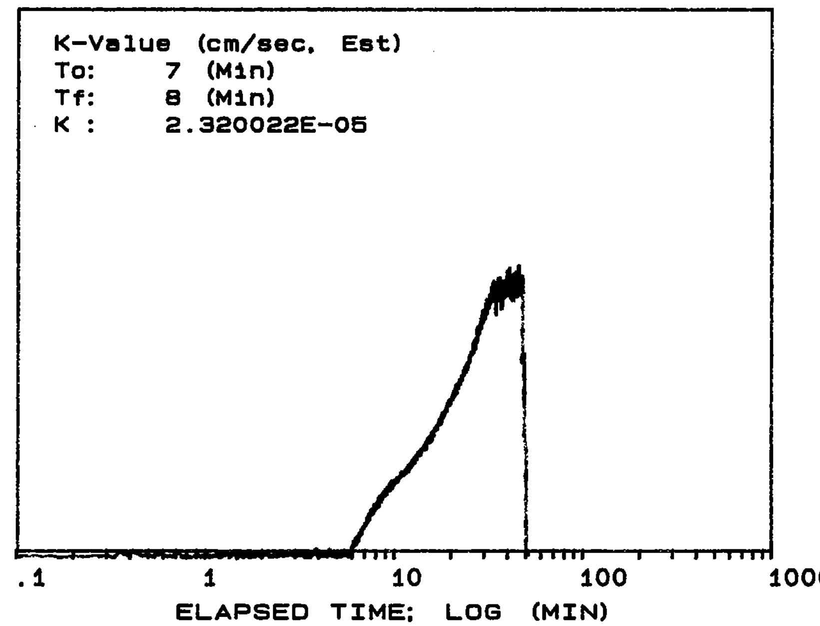
CLIENT: ENSAFE JOB: NASM094

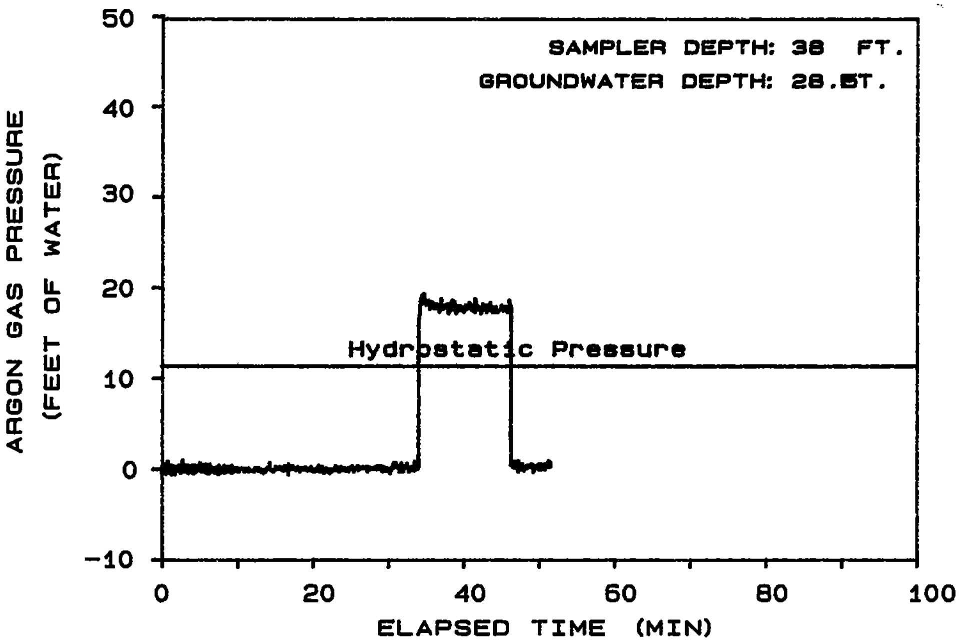
DATE: 12-10-1994 LOCATION: SWMU7 ST23

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

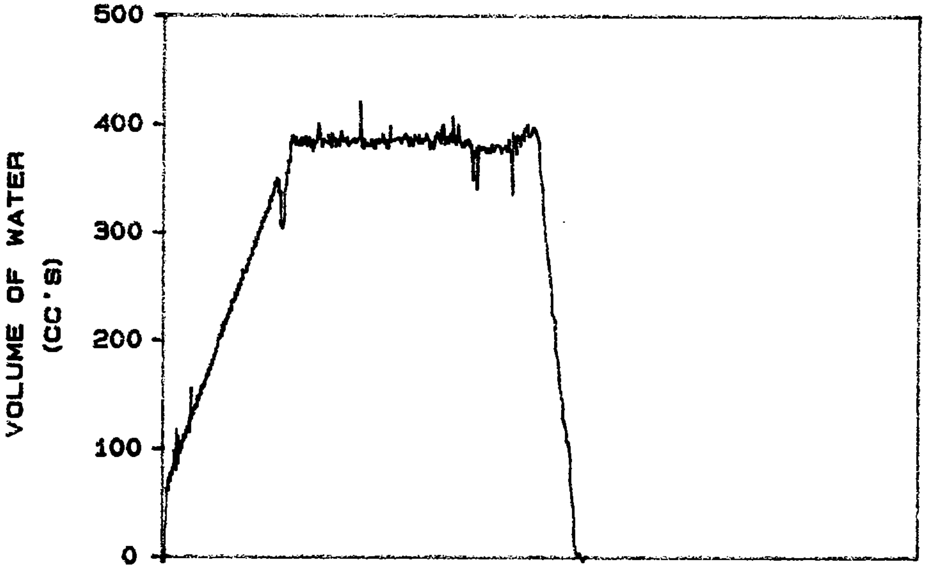
SAMPLE #: 7GH1039

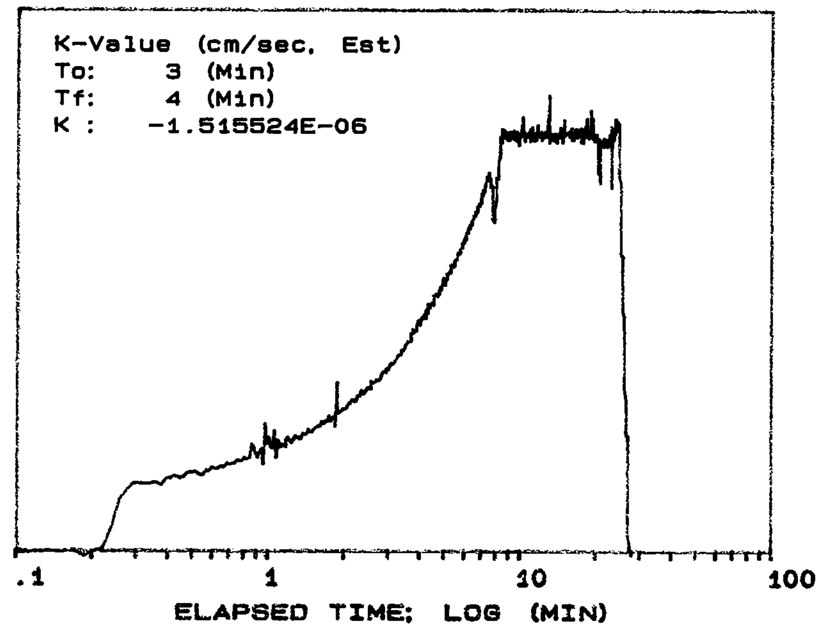
CLIENT: ENSAFE JOB: NASM094

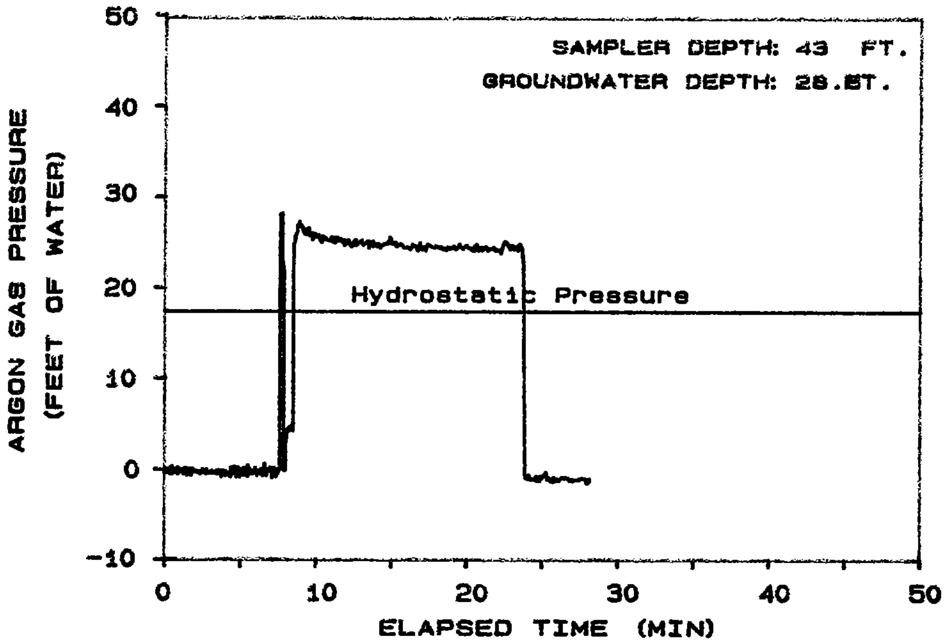
DATE: 12-1-94 LOCATION: SWMU7 ST10

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

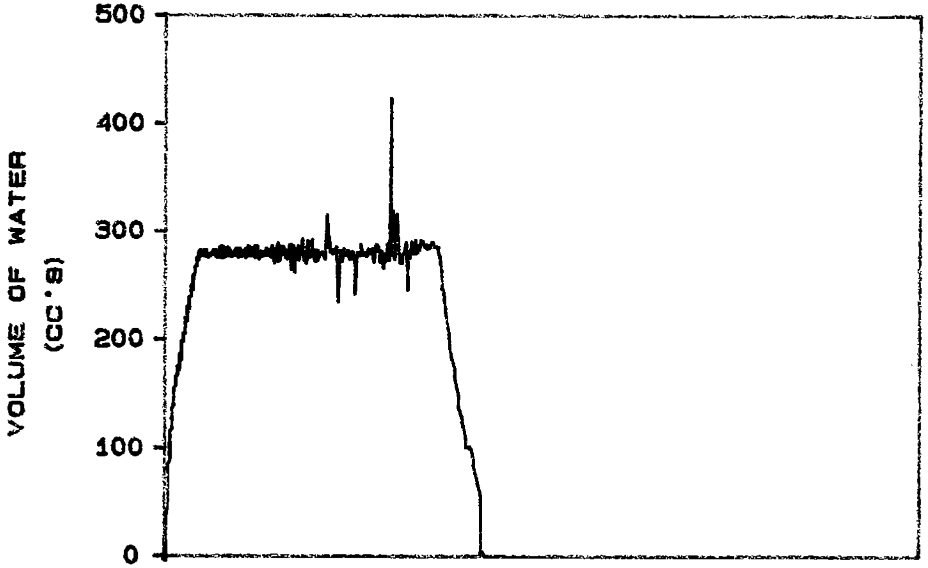
SAMPLE #: 7GH1143

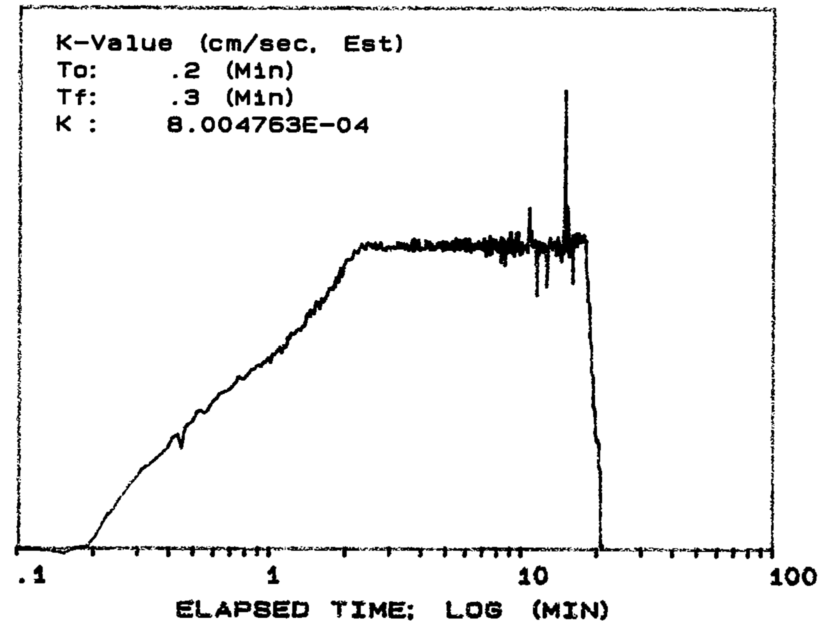
CLIENT: ENSAFE JOB: NASM094

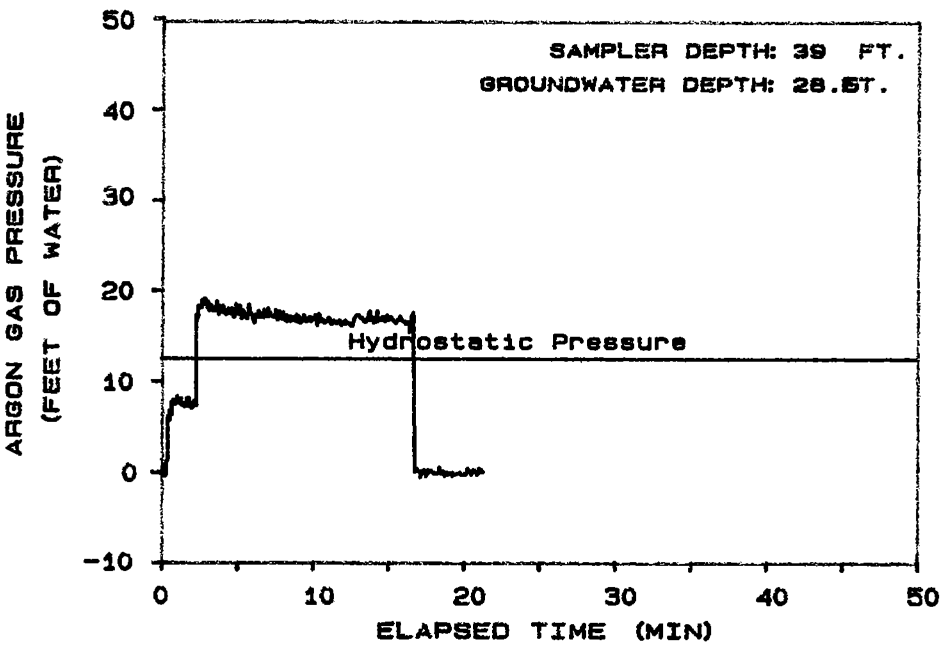
DATE: 12-02-1994 LOCATION: SWMU7 ST11

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

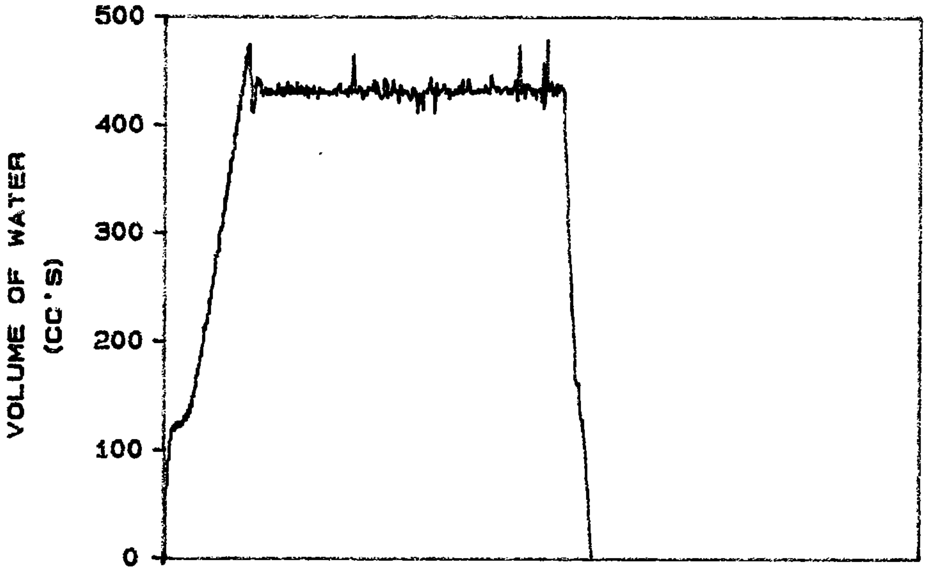
SAMPLE #: 7GH1339

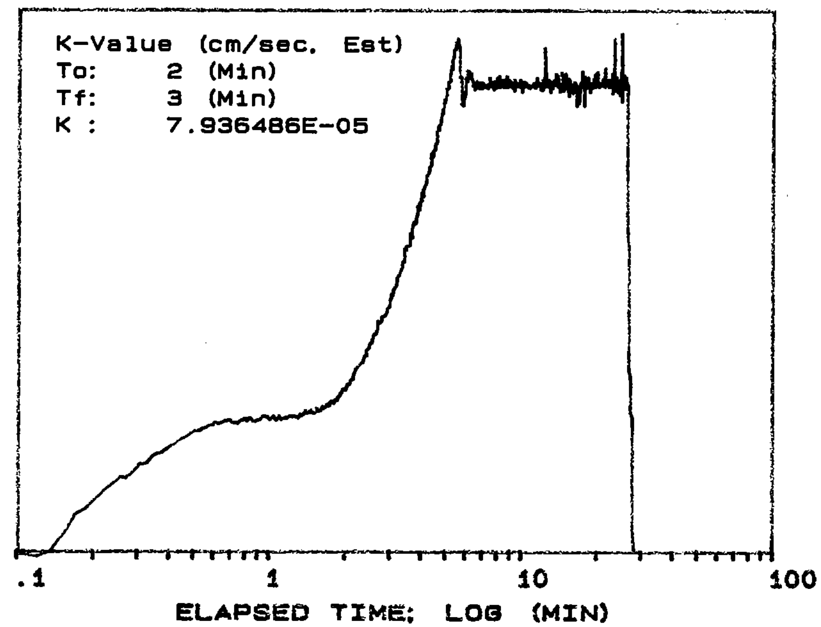
CLIENT: ENSAFE JOB: NASM04

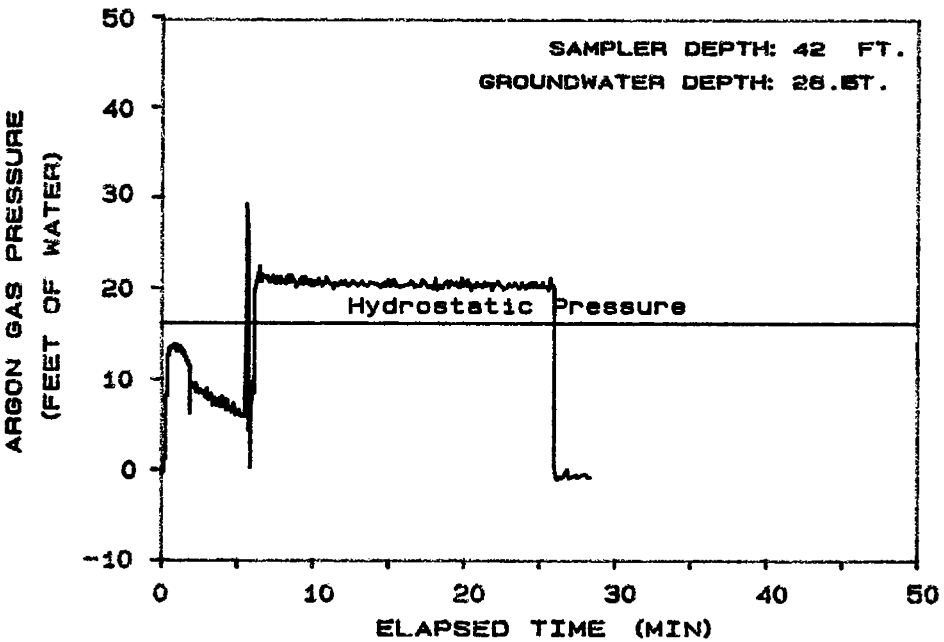
DATE: 12-02-1994 LOCATION: SWMU7 ST13

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

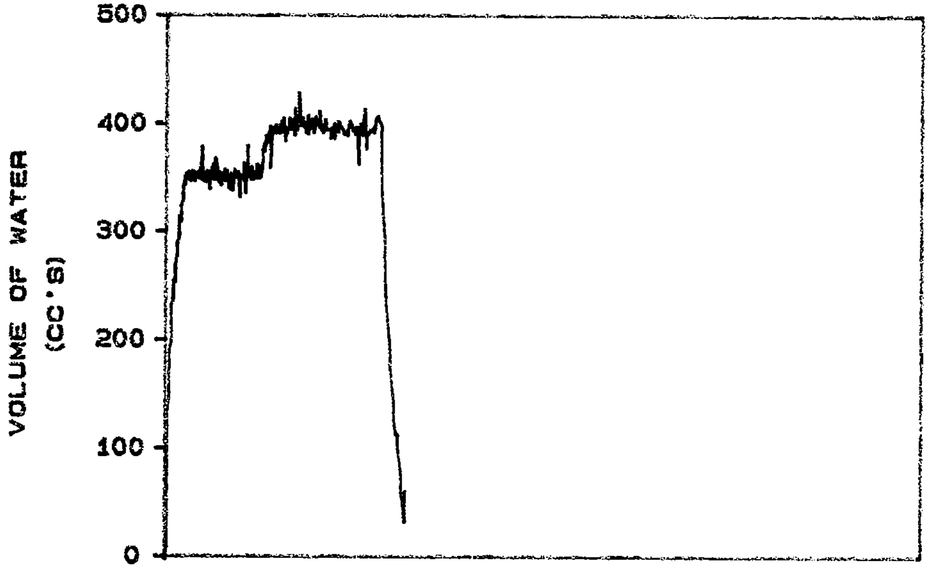
SAMPLE #: 7GH1442

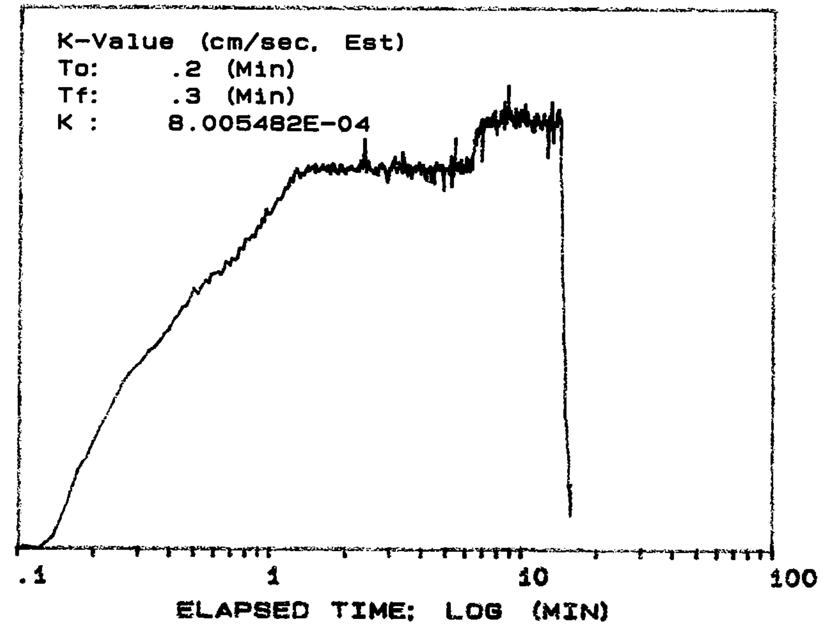
CLIENT: ENSAFE　JOB: NASM094

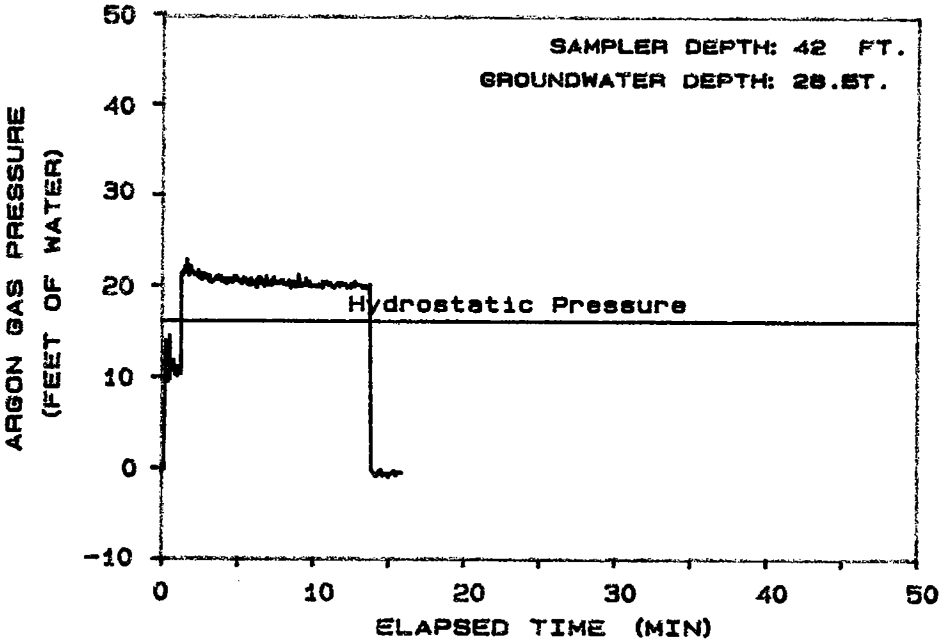
DATE: 12-02-1994　LOCATION: SWMU7 ST14

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

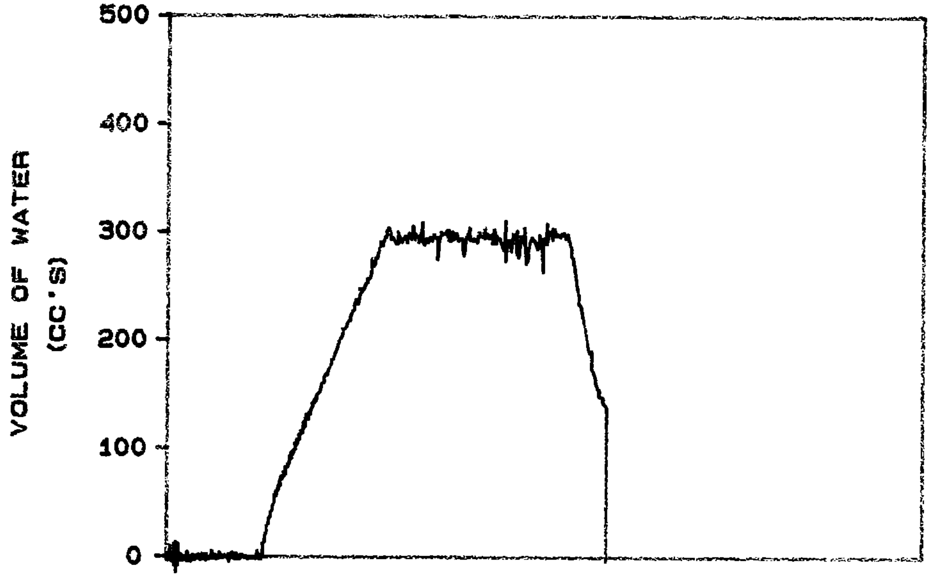
SAMPLE #: 7GH1542

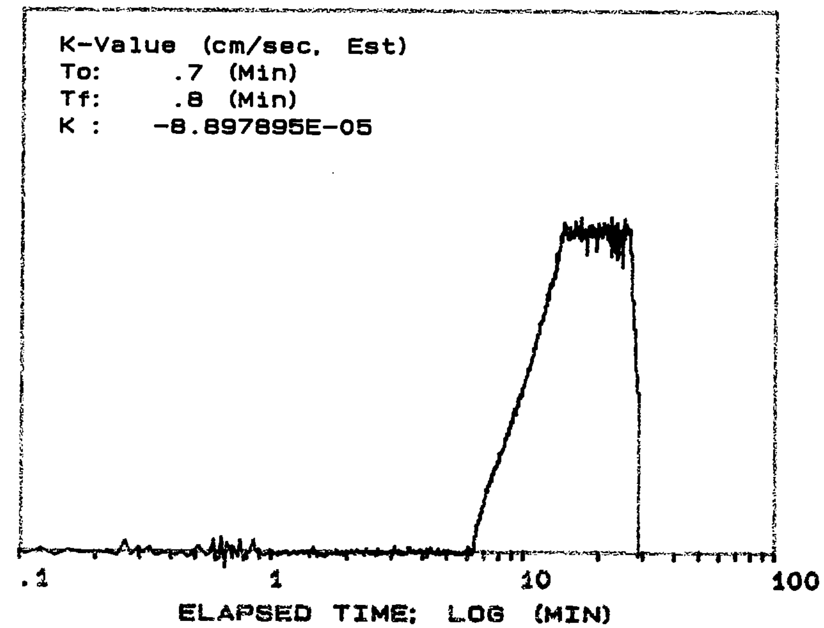
CLIENT: ENSAFE JOB: NASM094

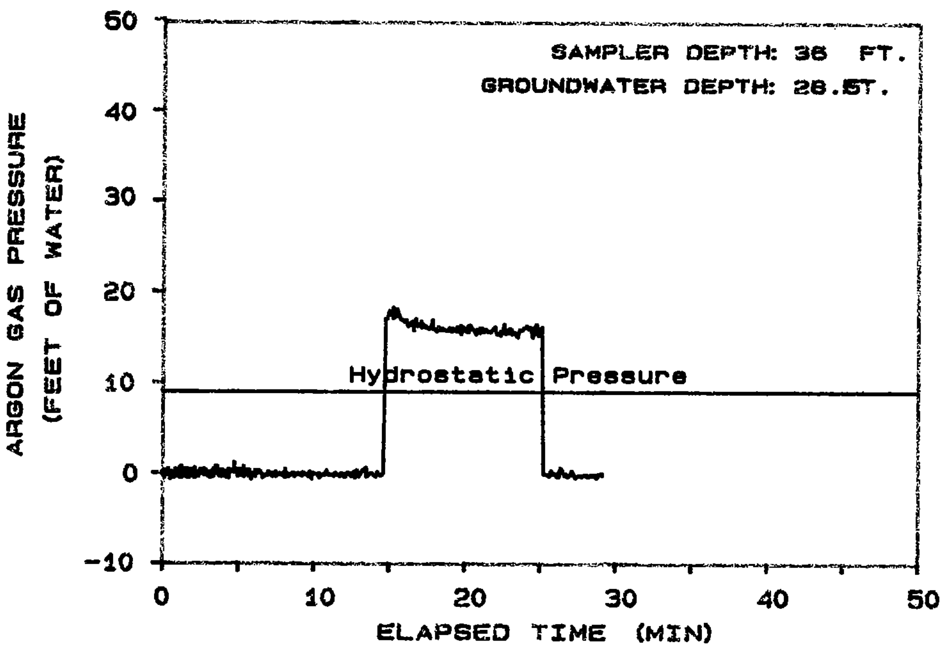
DATE: 12-03-1994 LOCATION: SWMU7 ST16

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

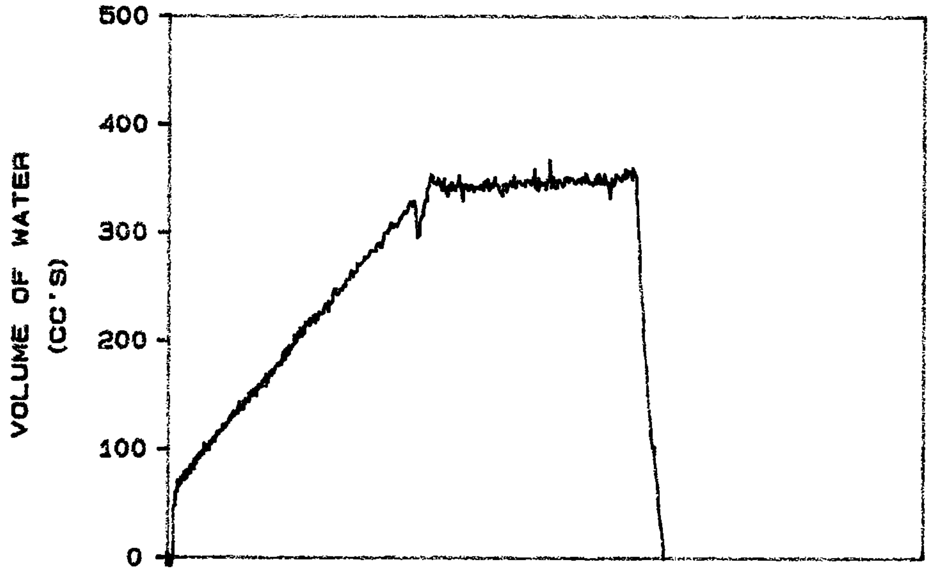
SAMPLE #: 7GH1636

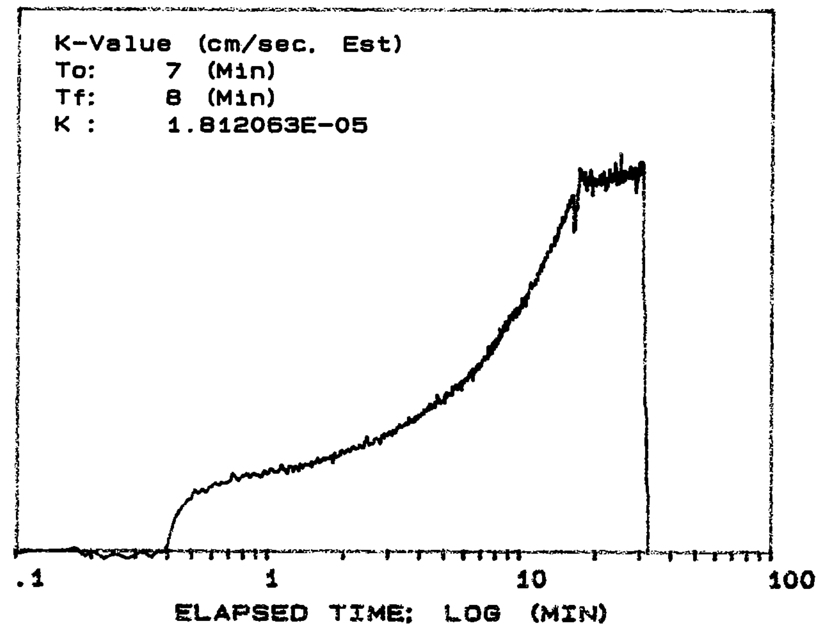
CLIENT: ENSAFE JOB: NASM094

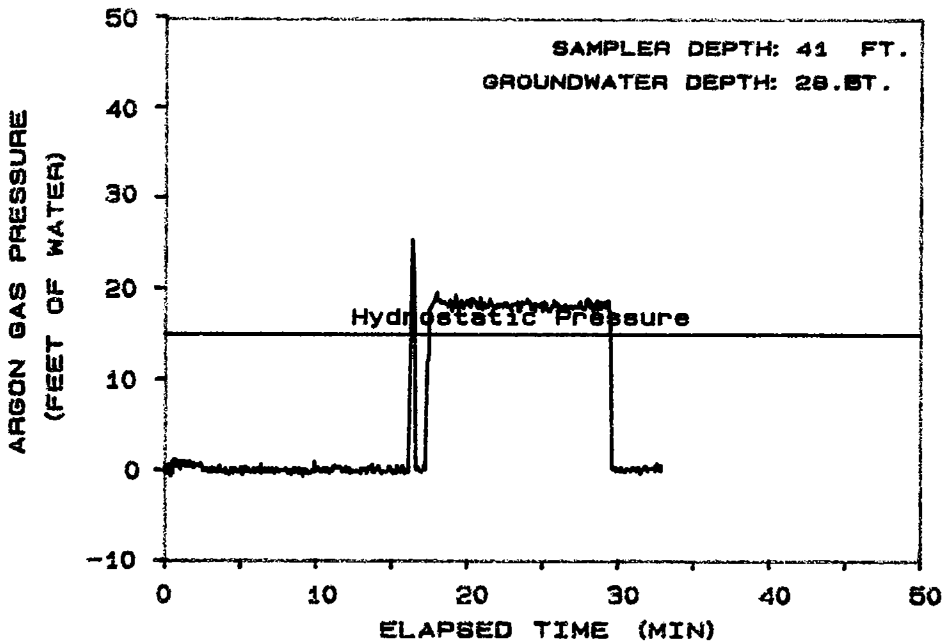
DATE: 12-03-1994 LOCATION: SWMU7 ST15

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

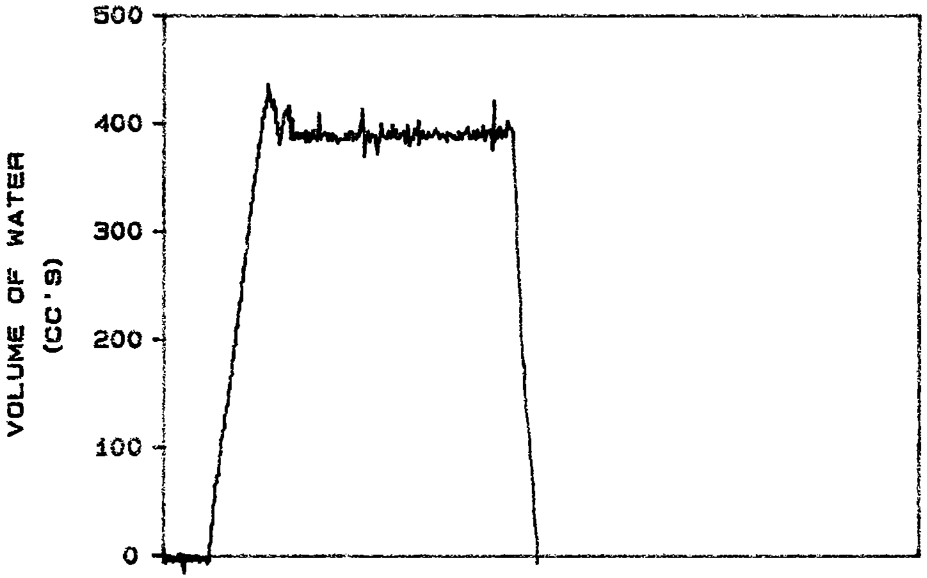
SAMPLE #: 7GH1741

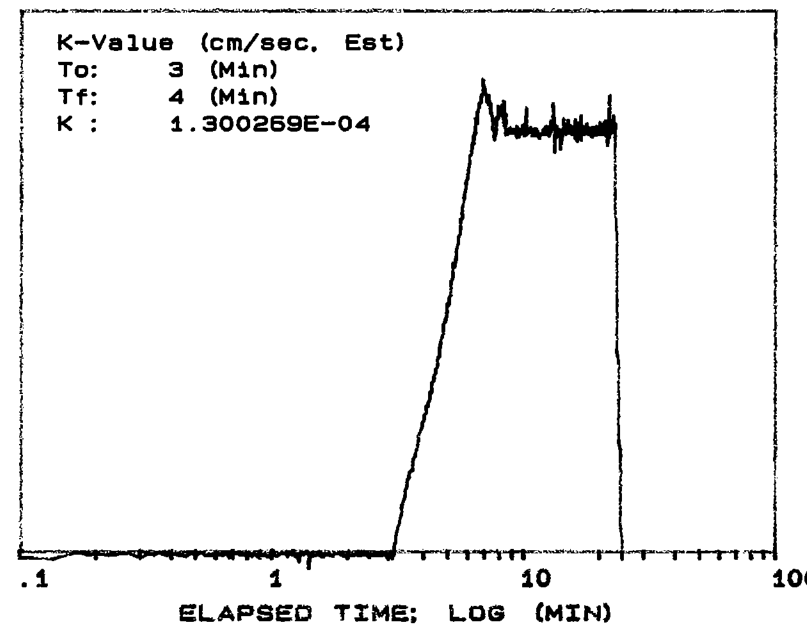
CLIENT: ENSAFE JOB: NASM094

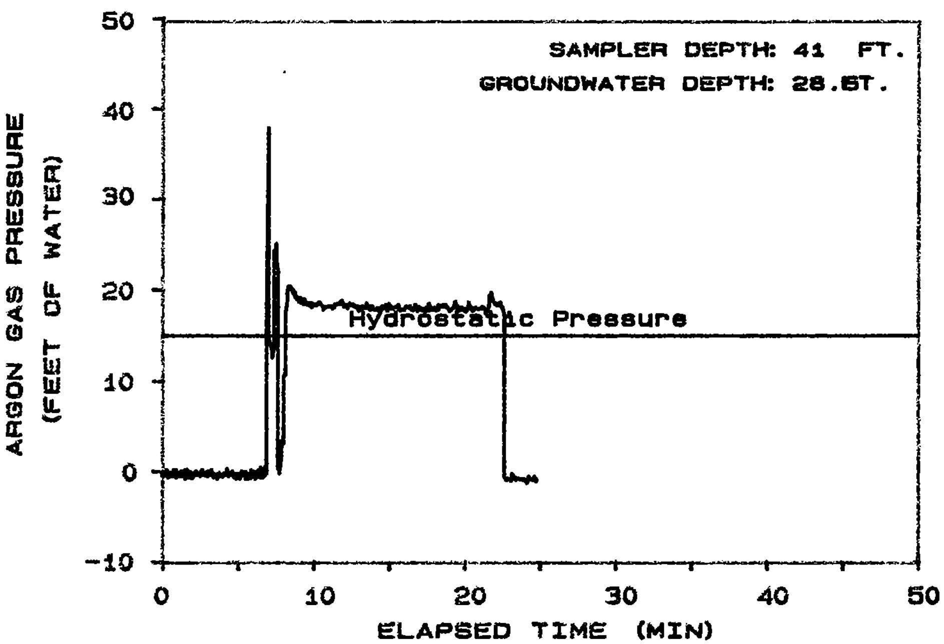
DATE: 12-03-1994 LOCATION: SWMU7 ST17

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

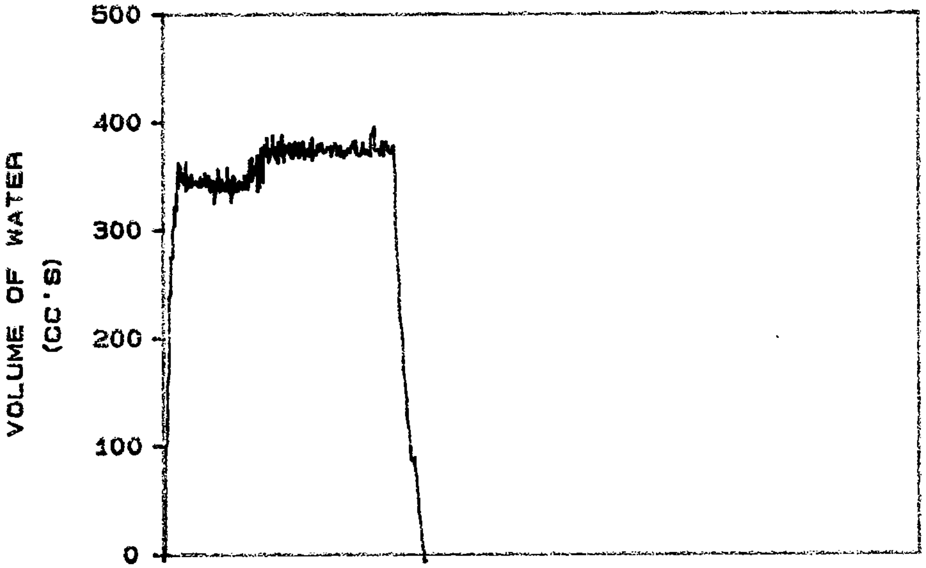
SAMPLE #: 7GH1841

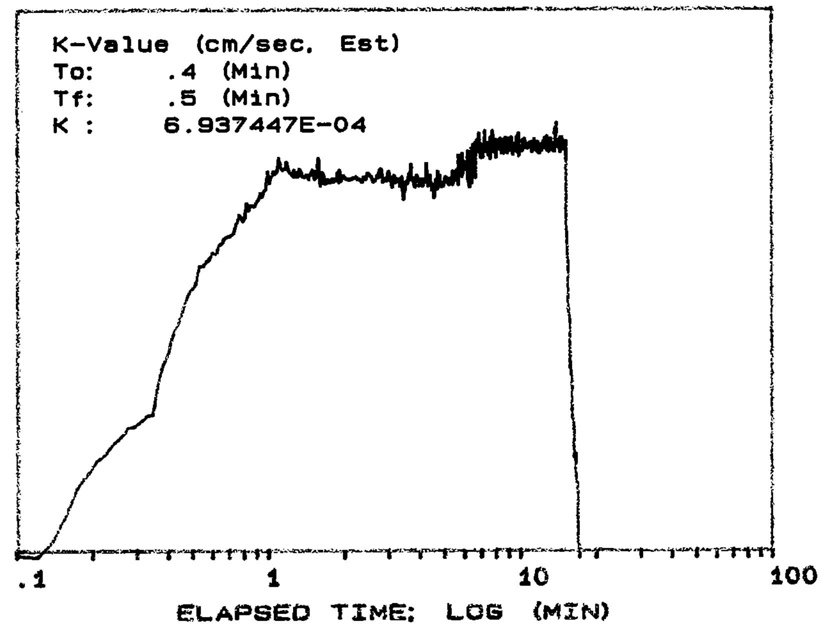
CLIENT: ENSAFE JOB: NASM094

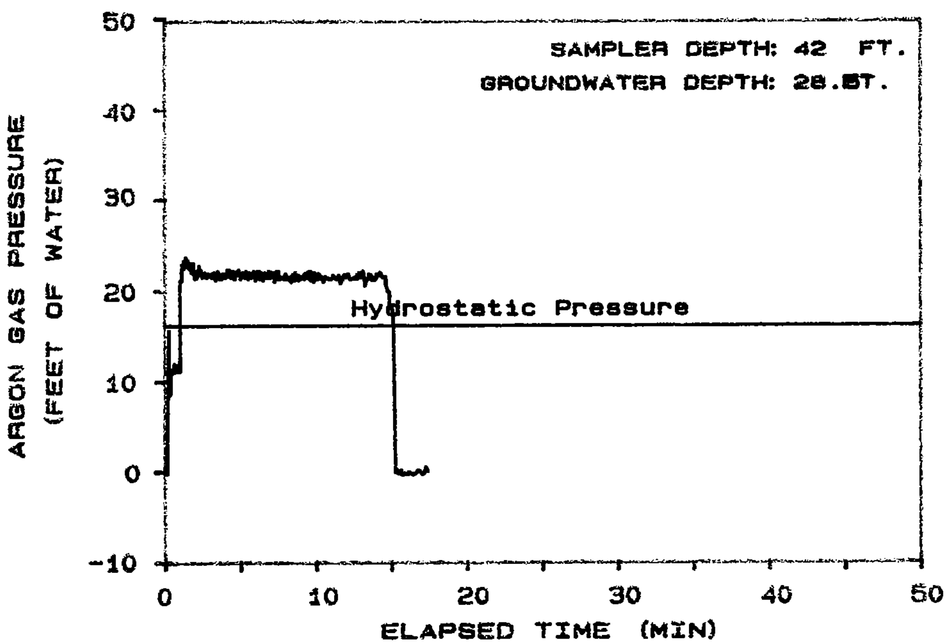
DATE: 12-03-1984 LOCATION: SWMU7 ST18

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

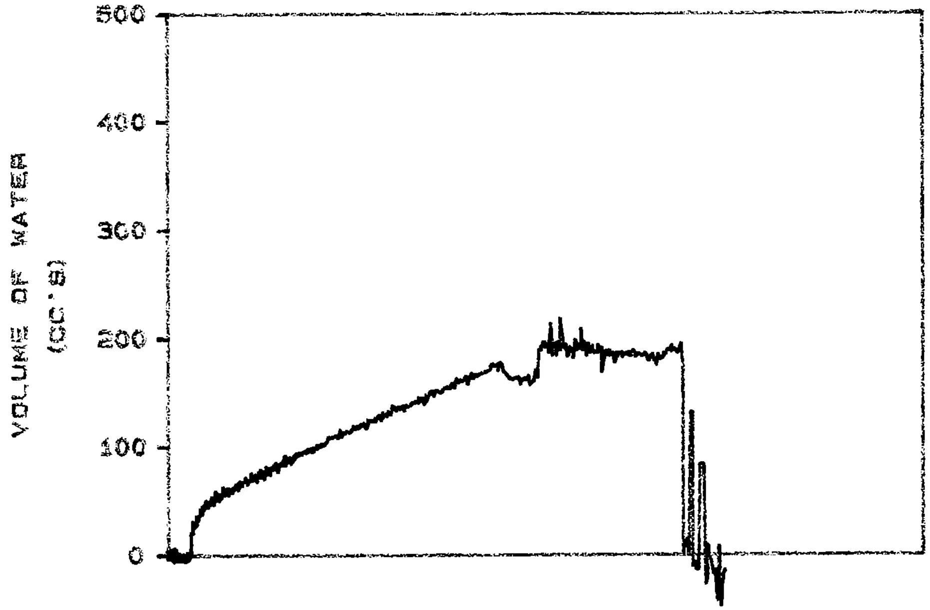
SAMPLE #: 7GH1942

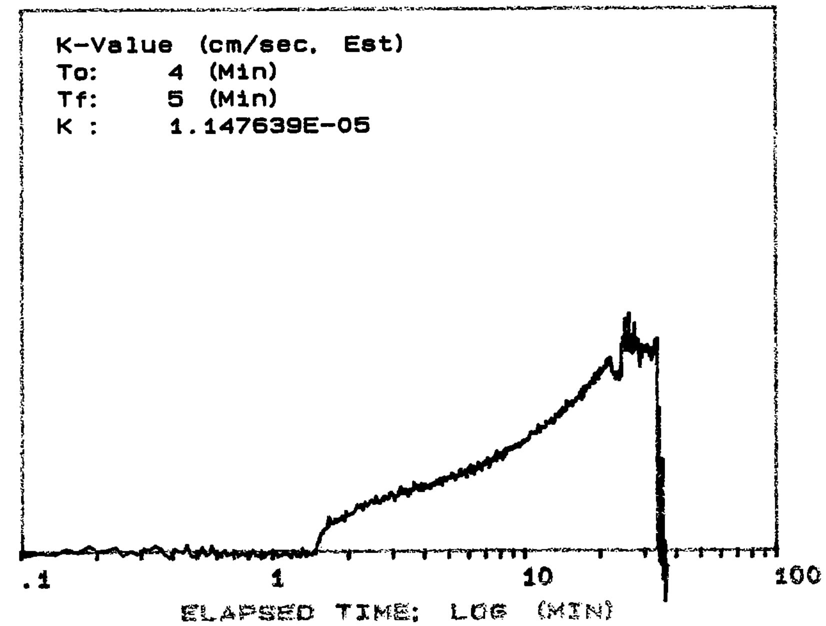
CLIENT: ENSAFE JOB: NASM094

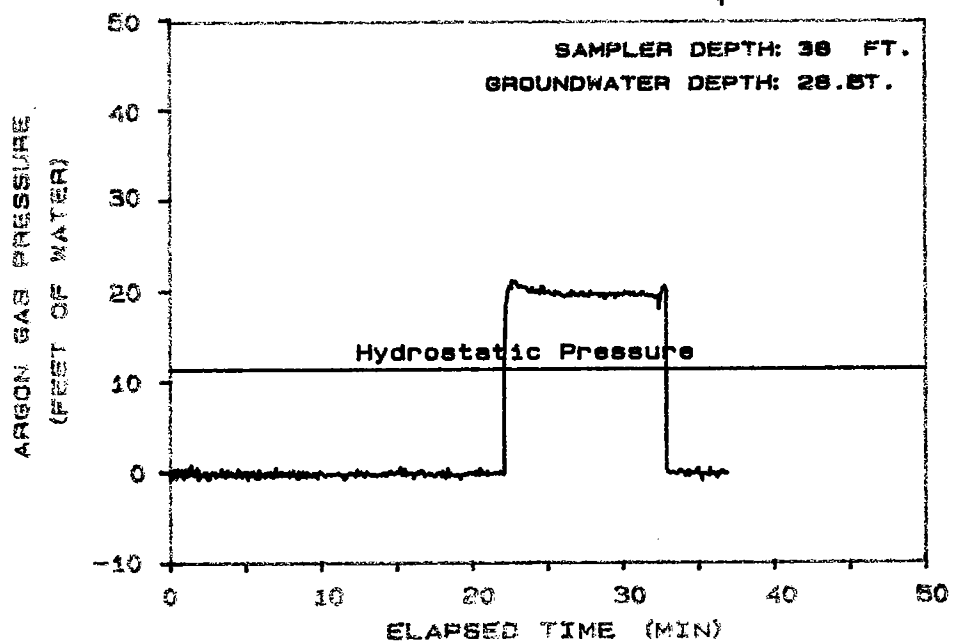
DATE: 12-03-1994 LOCATION: SWMU7 ST19

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

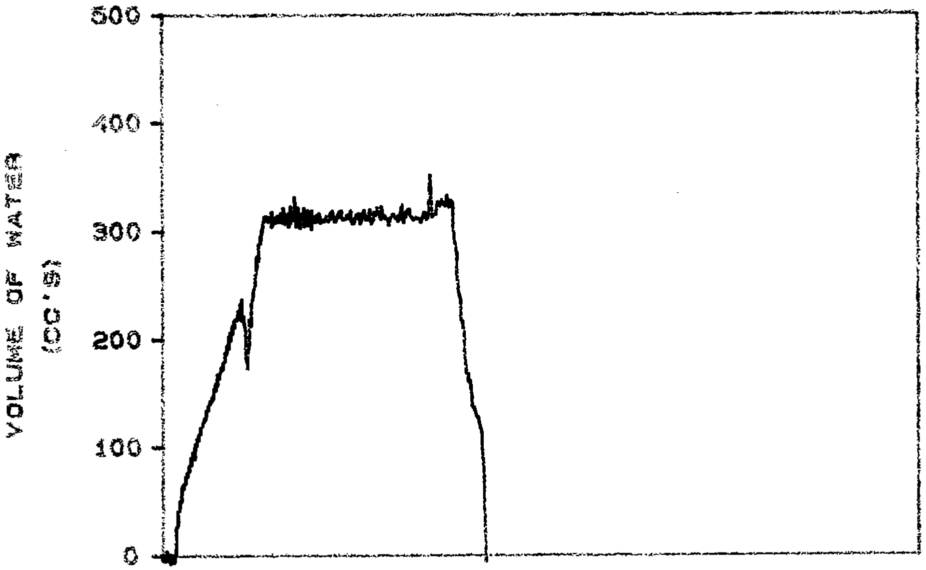
SAMPLE #: 7GH2038

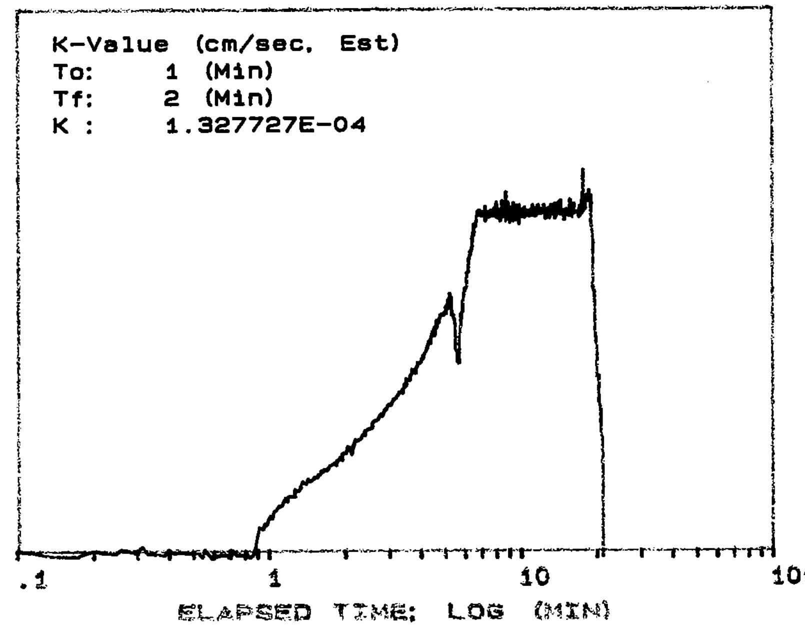
CLIENT: ENSAFE JOB: NASM094

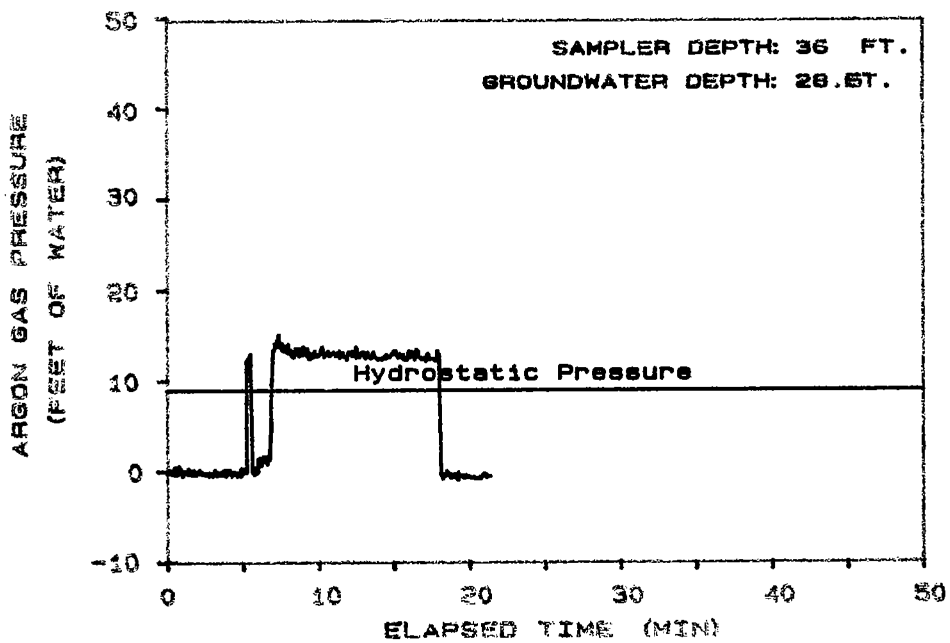
DATE: 12-08-1994 LOCATION: SWMU7 ST20

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

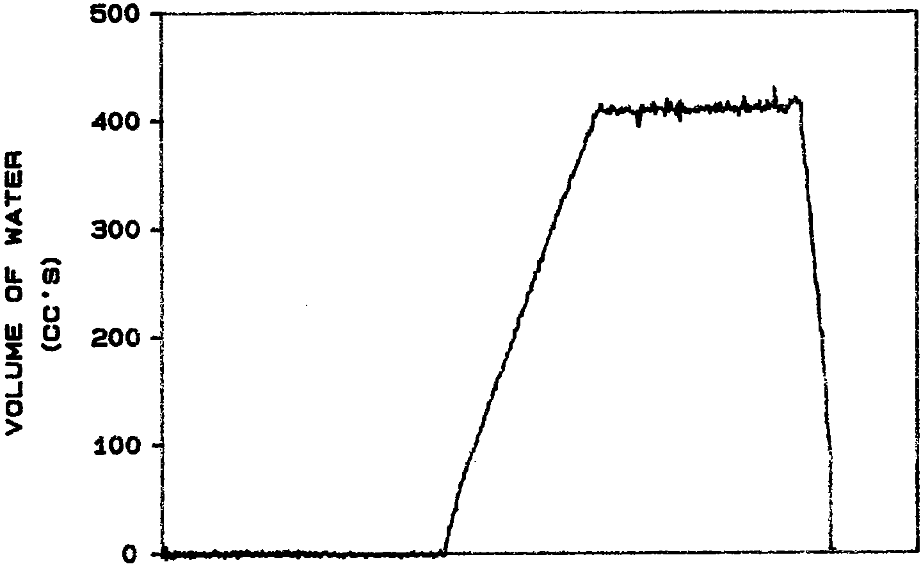
SAMPLE #: 7GH2136

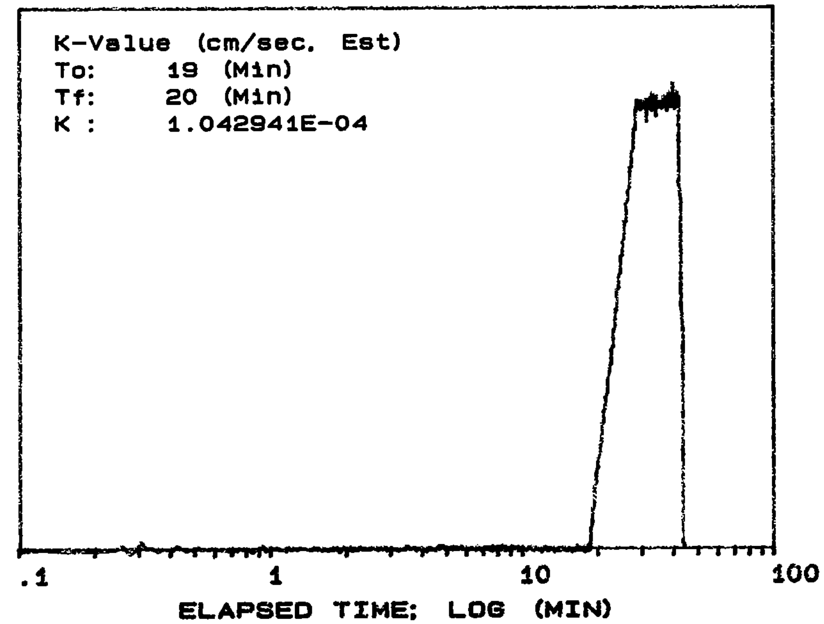
CLIENT: ENSAFE   JOB: NASM094

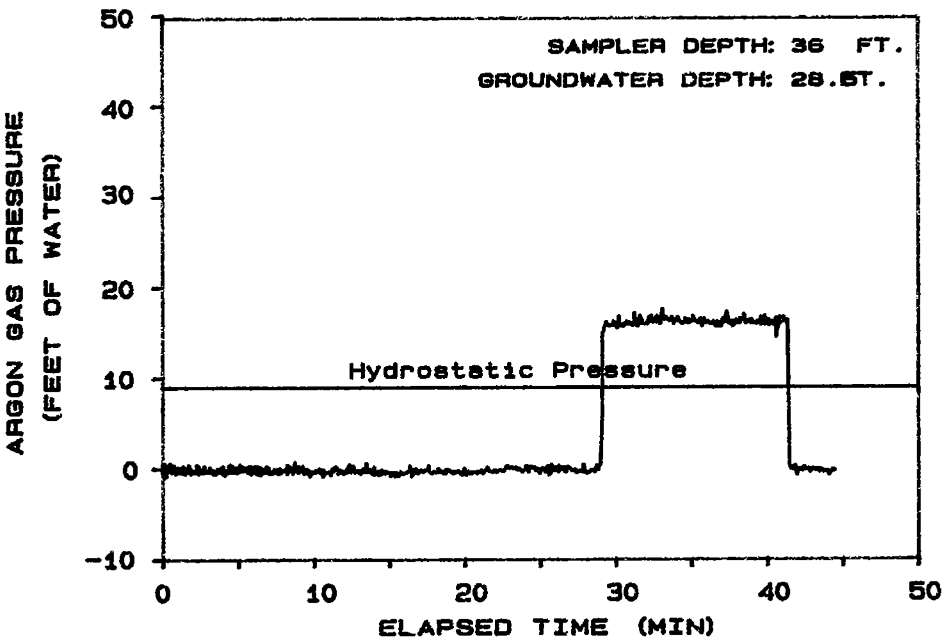
DATE: 12-06-1994   LOCATION: SWMU7 ST21

PERFORMED BY:

SUBSURFACE TECHNOLOGY







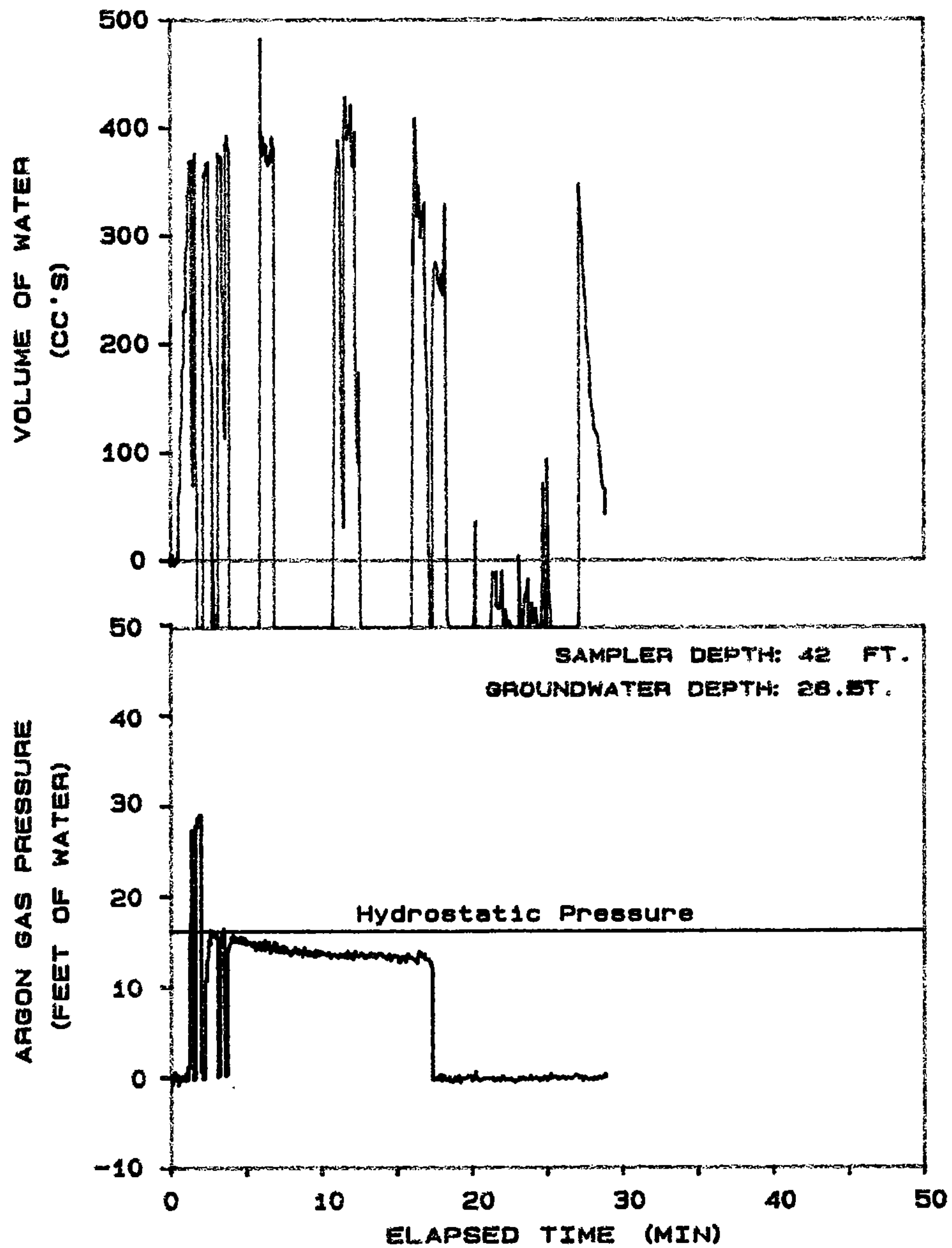
GS-1 SAMPLE PLOT

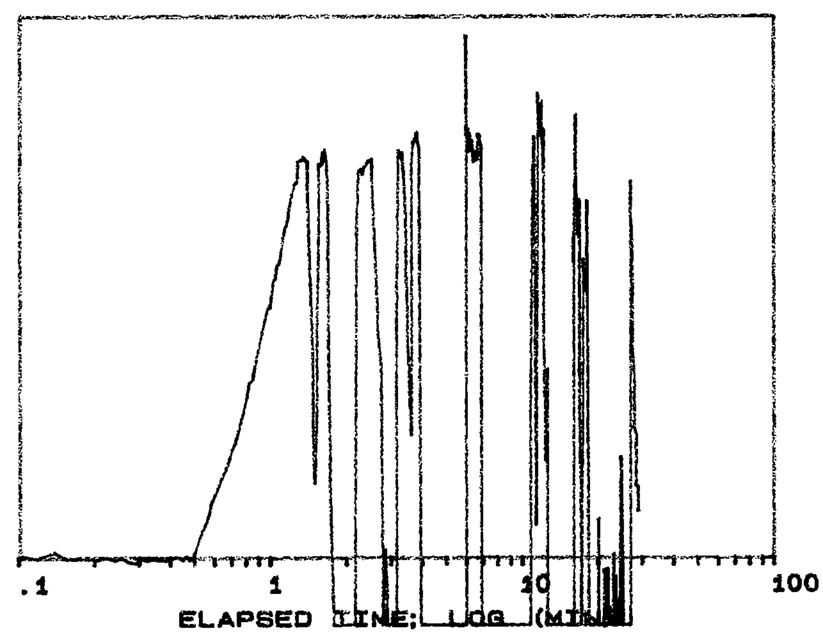
SAMPLE #: 7GH0236

CLIENT:	ENSAFE	JOB:	NASM094
DATE:	11-21-1994	LOCATION:	SWMU7 ST2

PERFORMED BY:

SUBSURFACE TECHNOLOGY





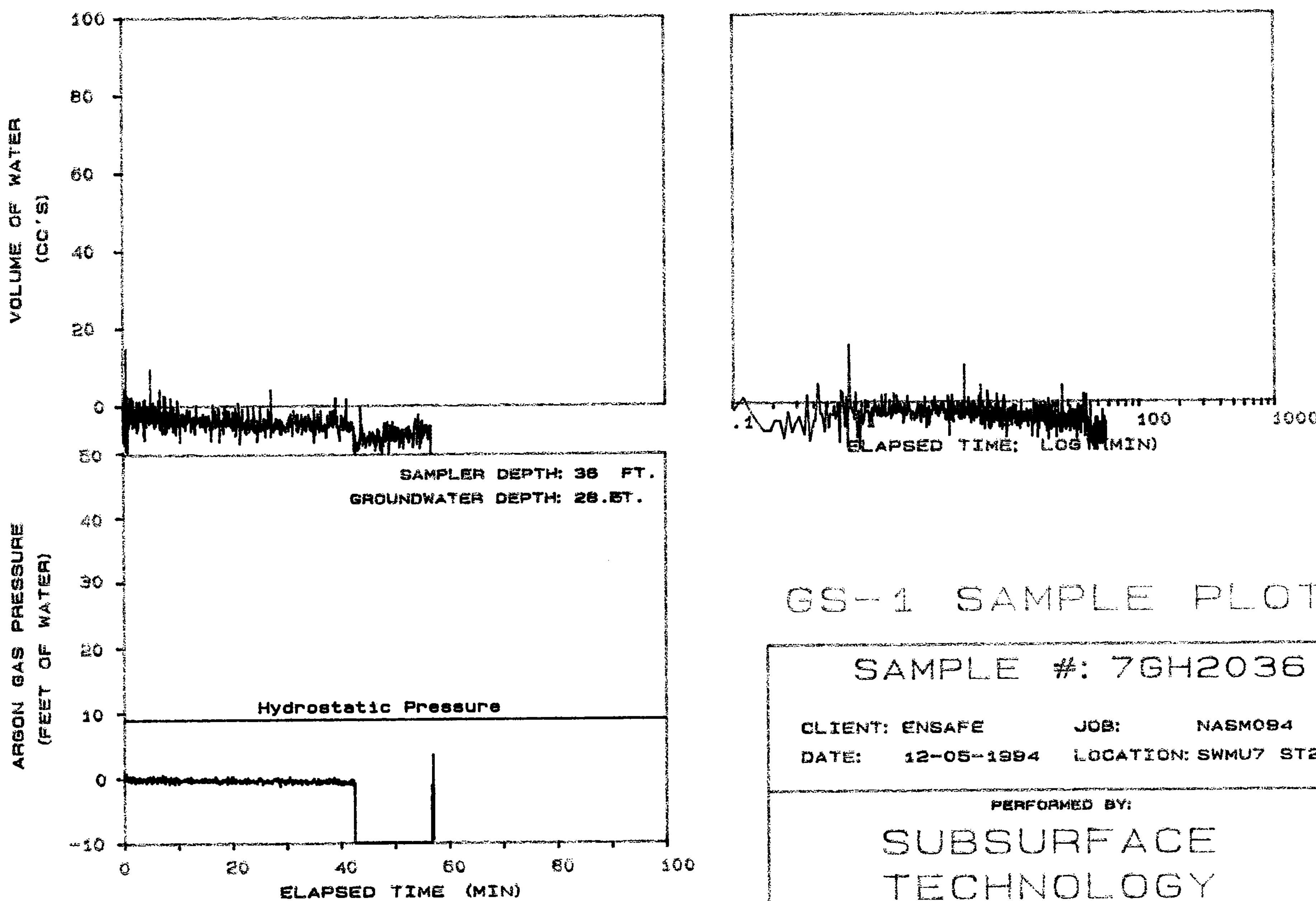
GS-1 SAMPLE PLOT

SAMPLE #: 7GH1242

CLIENT:	ENSAFE	JOB:	NASM094
DATE:	12-02-1994	LOCATION:	SWMU7 ST12

PERFORMED BY:

SUBSURFACE TECHNOLOGY



GS-1 SAMPLE PLOT

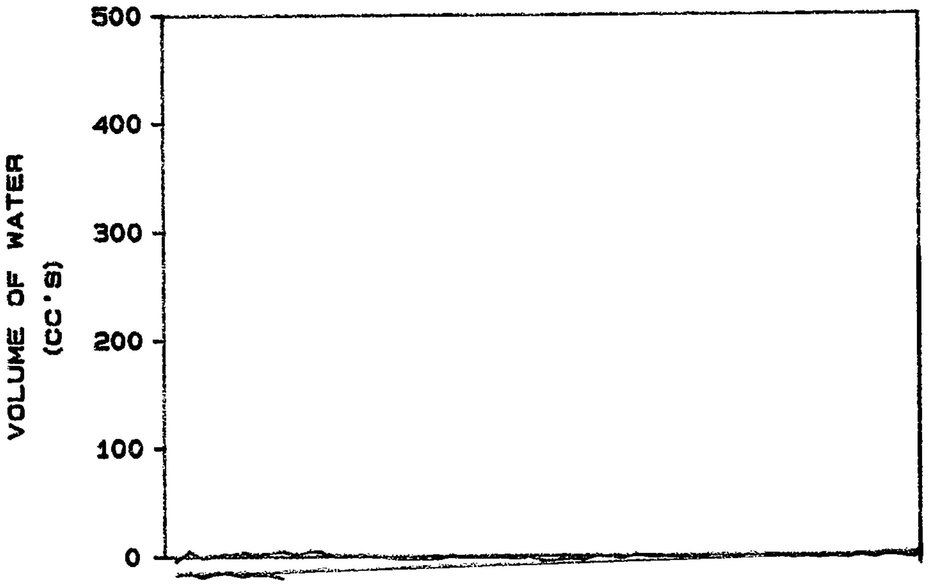
SAMPLE #: 7GH2036

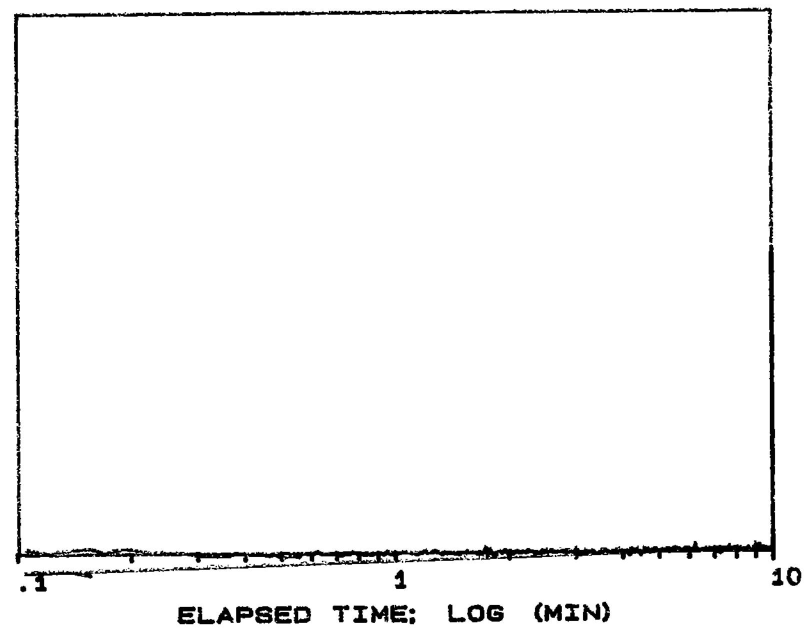
CLIENT: ENSAFE JOB: NASM094

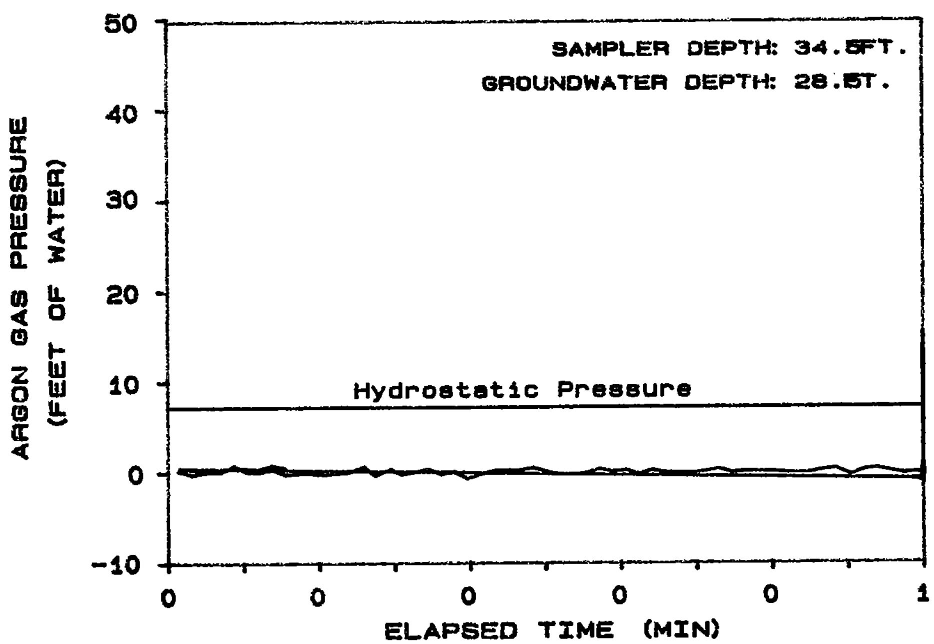
DATE: 12-05-1994 LOCATION: SWMU7 ST20

PERFORMED BY:

SUBSURFACE TECHNOLOGY







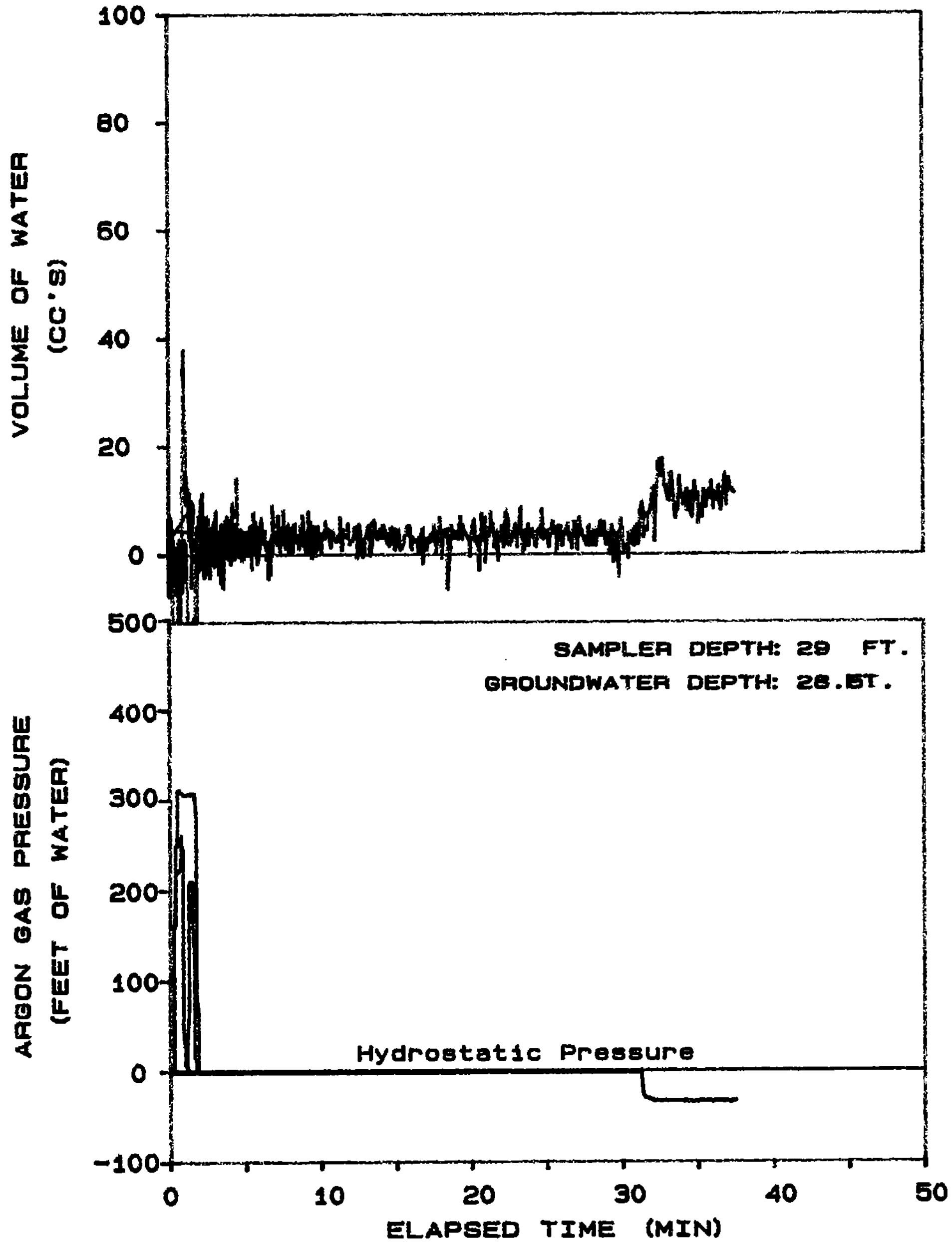
GS-1 SAMPLE PLOT

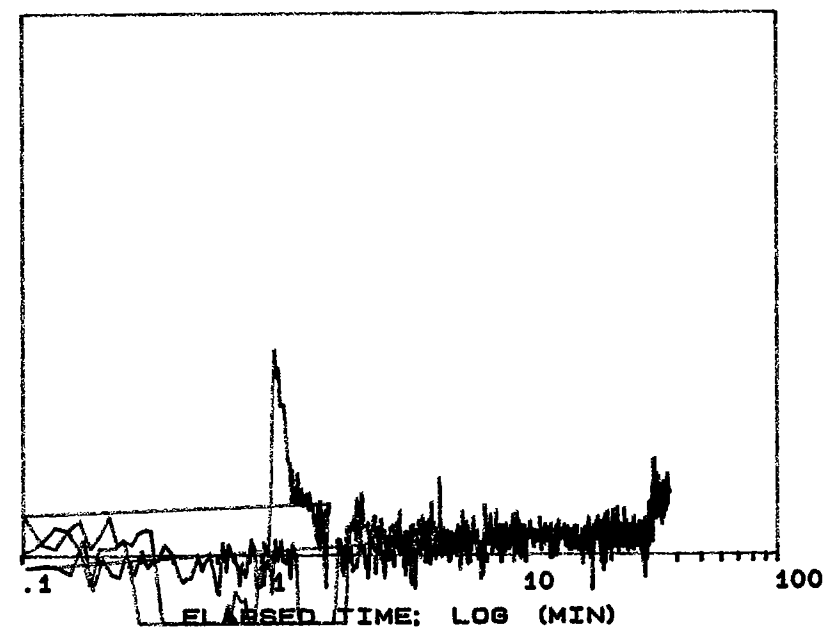
SAMPLE #: 7GH0334

CLIENT: ENSAFE	JOB: NASM094
DATE: 11-22-1994	LOCATION: SWMU7 ST3

PERFORMED BY:

SUBSURFACE TECHNOLOGY





GS-1 SAMPLE PLOT

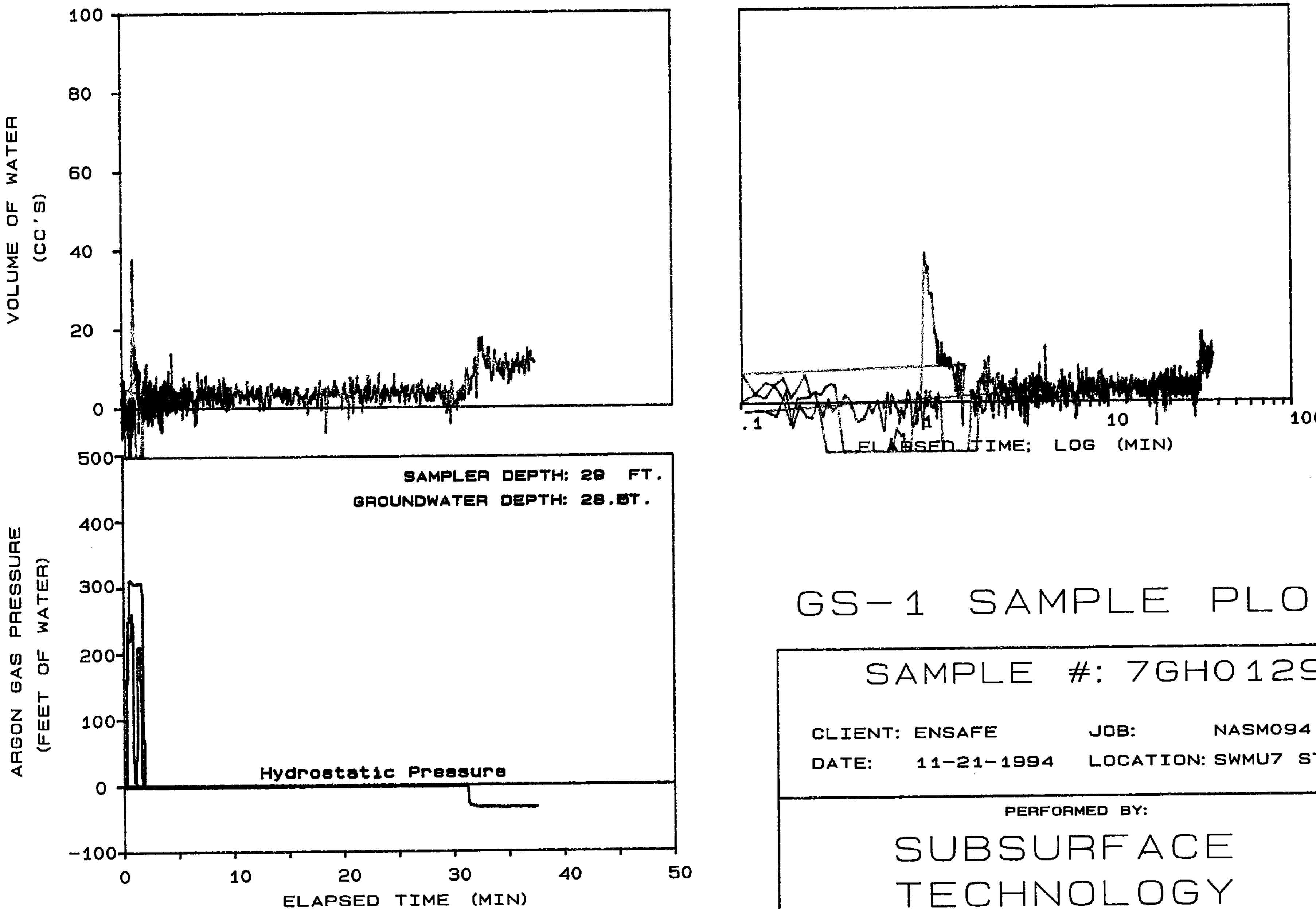
SAMPLE #: 7GH0129

CLIENT: ENSAFE JOB: NASM094

DATE: 11-21-1994 LOCATION: SWMU7 ST1

PERFORMED BY:

SUBSURFACE TECHNOLOGY



GS-1 SAMPLE PLOT

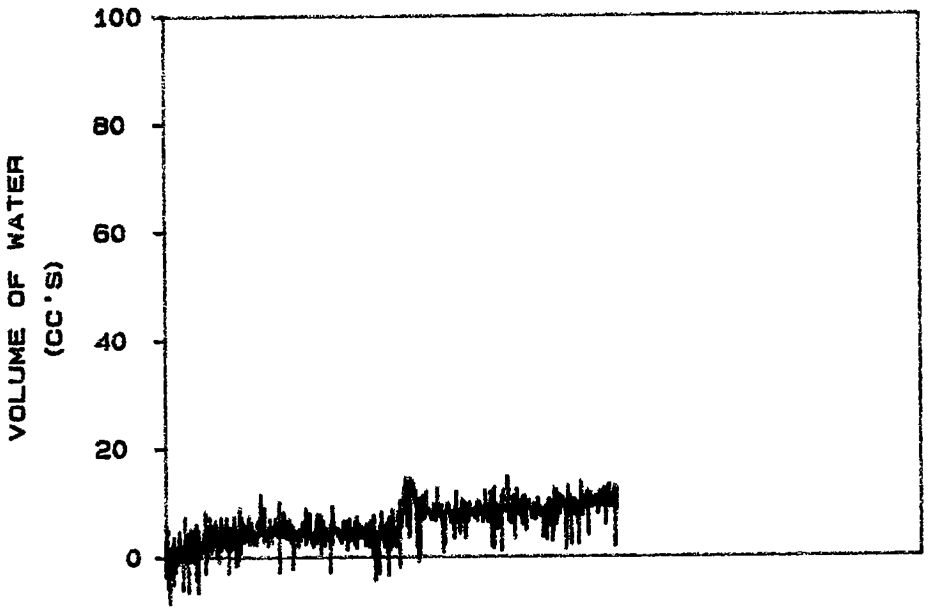
SAMPLE #: 7GH0129

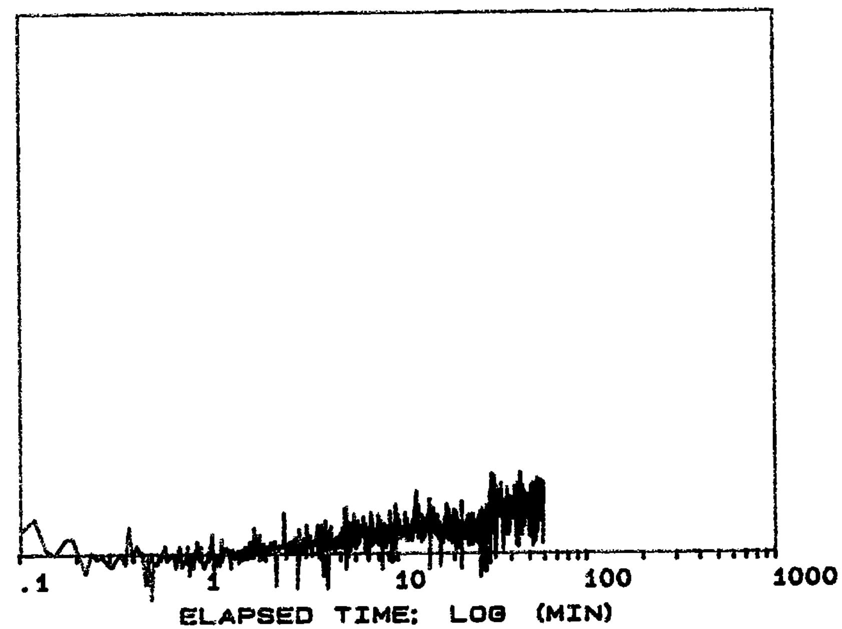
CLIENT: ENSAFE JOB: NASM094

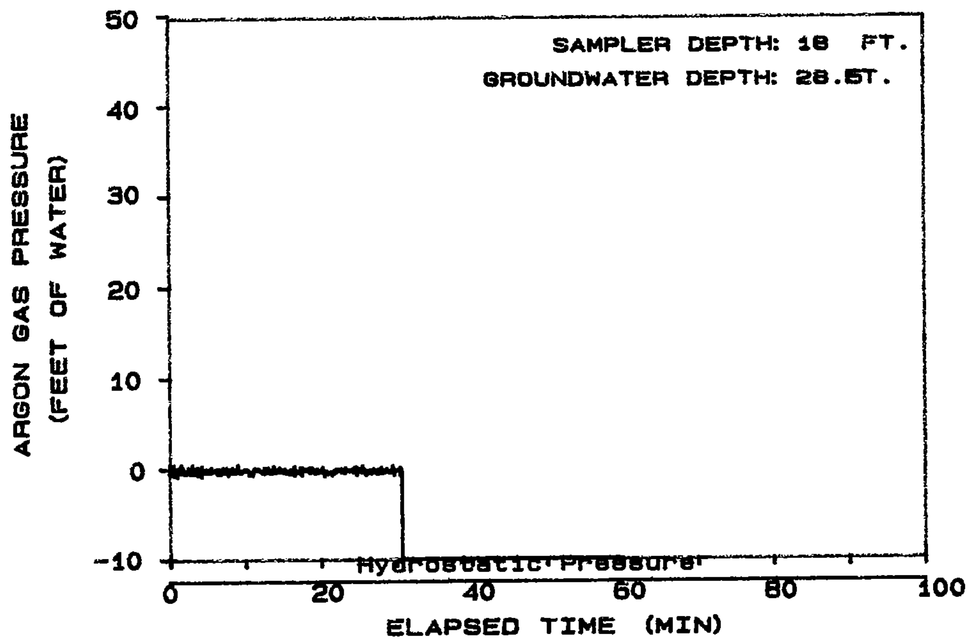
DATE: 11-21-1994 LOCATION: SWMU7 ST1

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

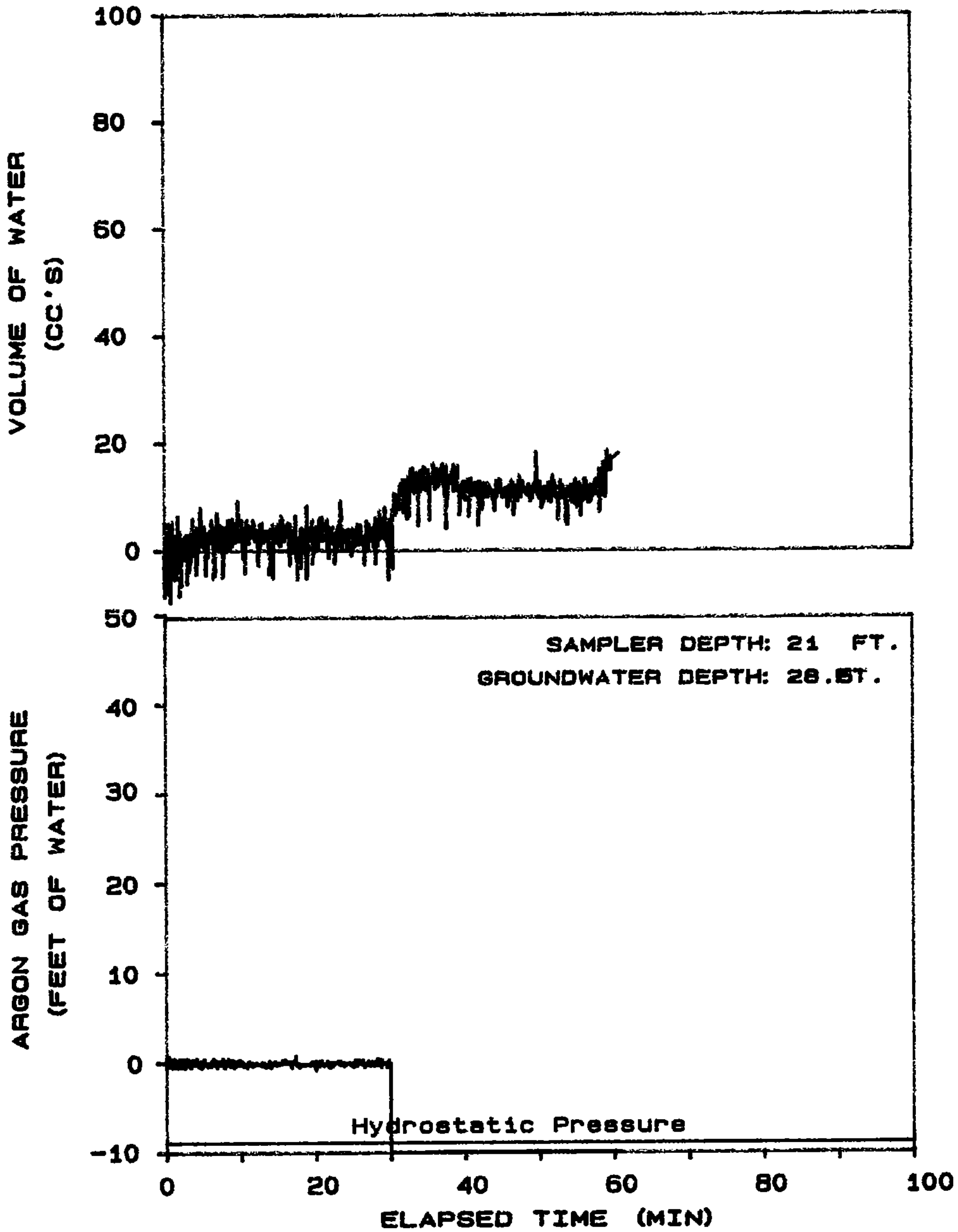
SAMPLE #: 7GH0118

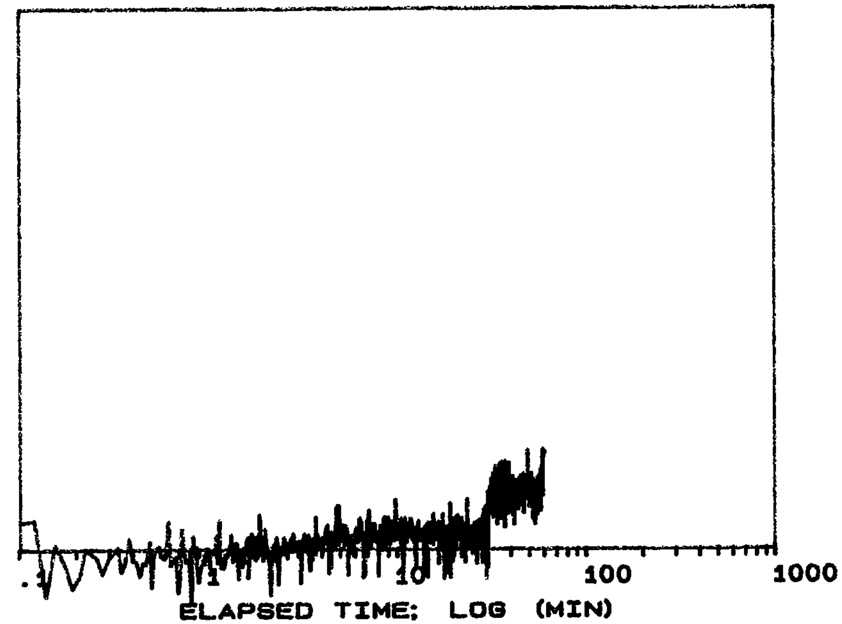
CLIENT: ENSAFE   JOB: NASM094

DATE: 11-20-1994   LOCATION: SWMU7 ST1

PERFORMED BY:

SUBSURFACE TECHNOLOGY





GS-1 SAMPLE PLOT

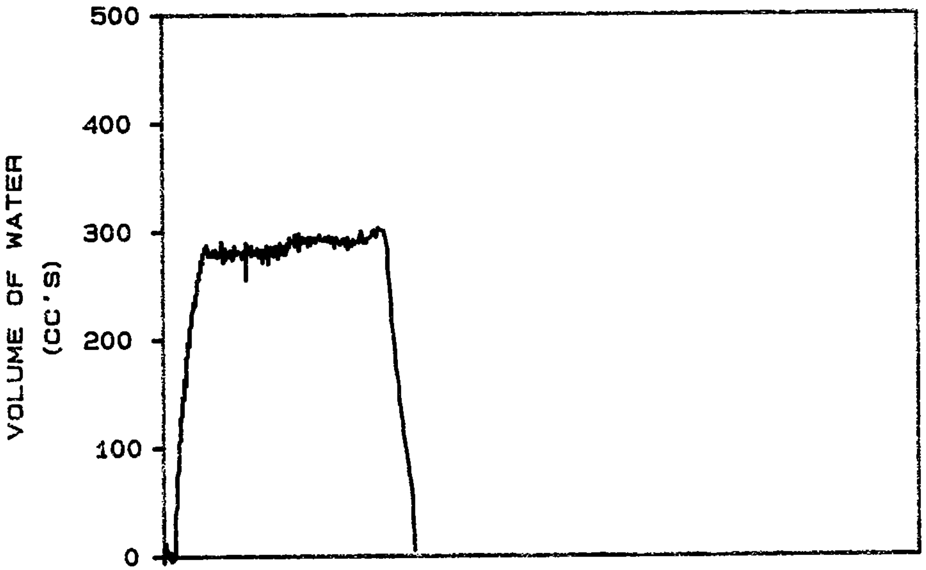
SAMPLE #: 7GH0121

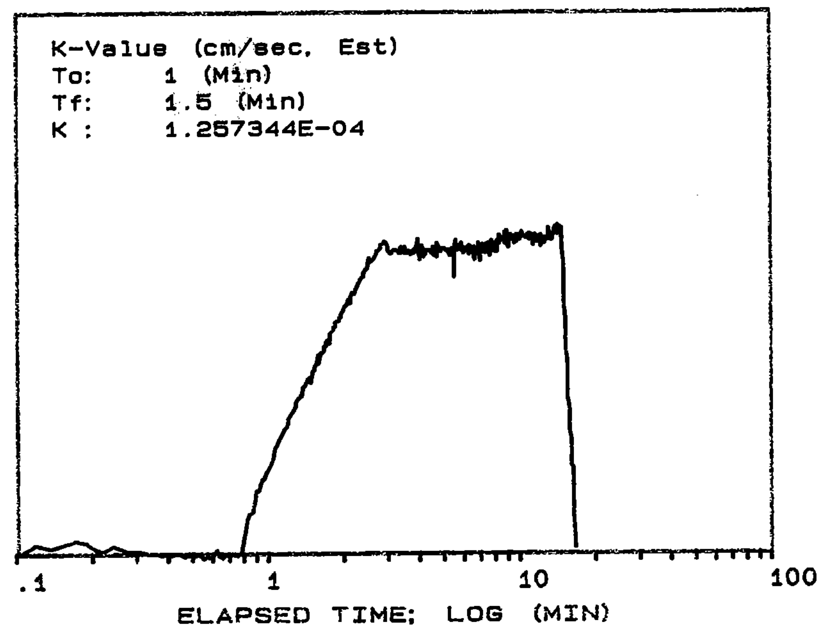
CLIENT: ENSAFE JOB: NASM094

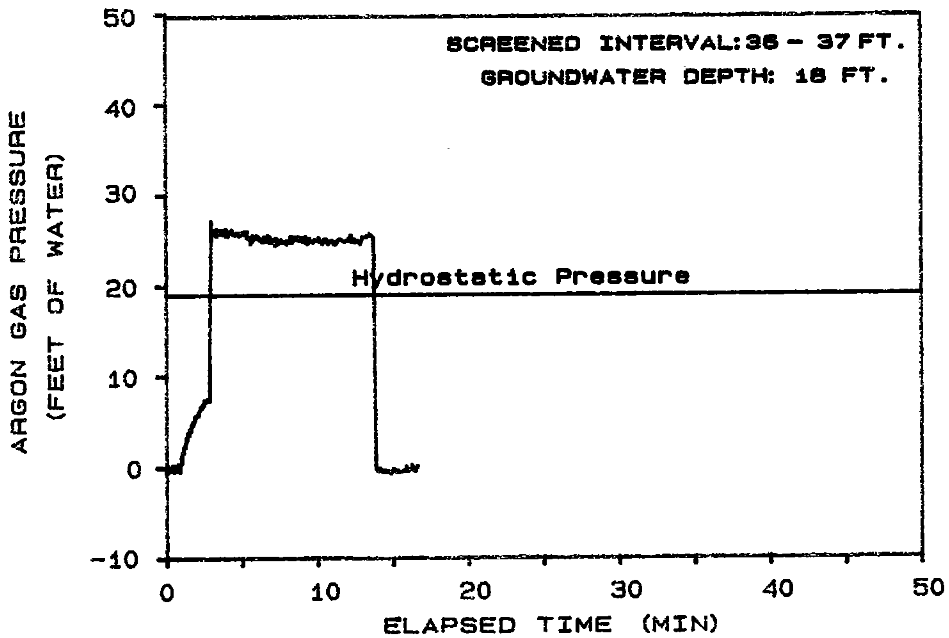
DATE: 11-20-1994 LOCATION: SWMU7 ST1

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

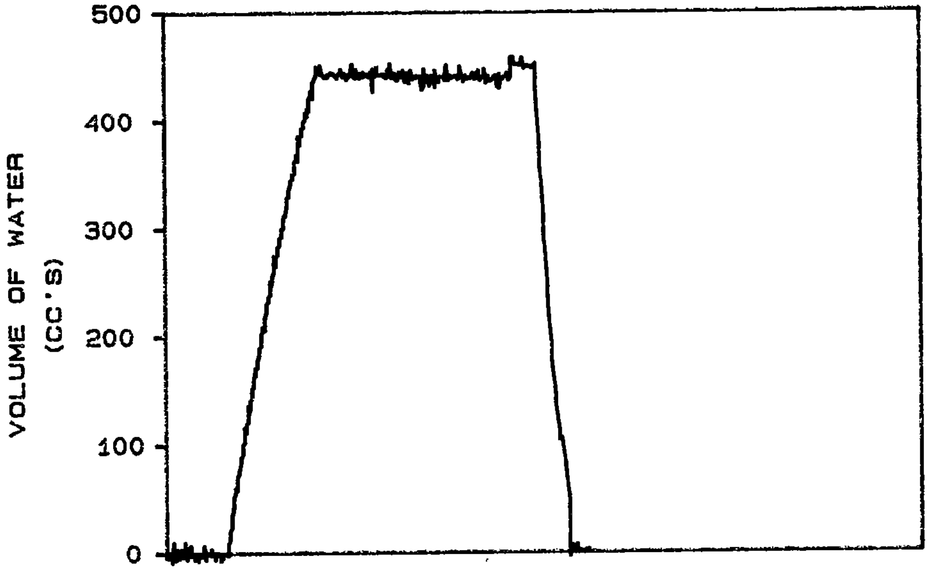
SAMPLE #: 07GH2437

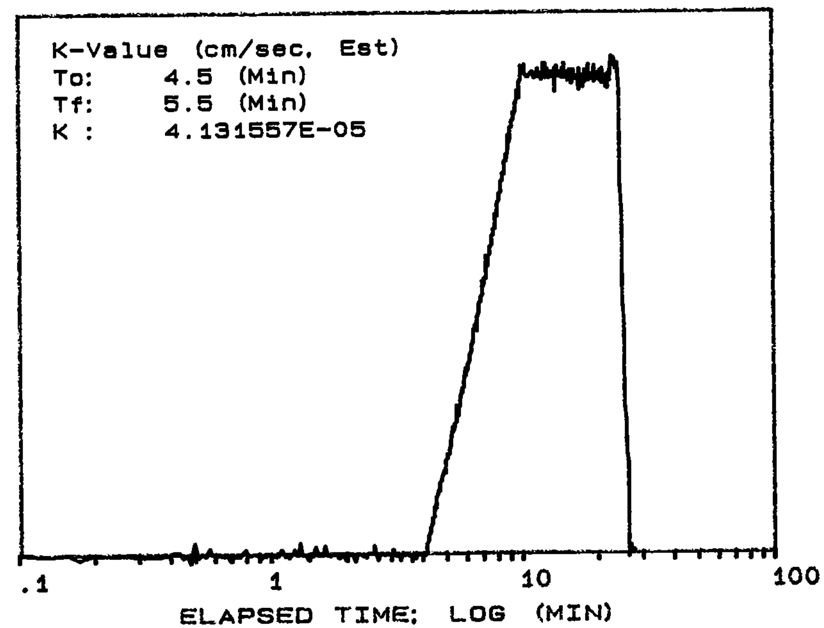
CLIENT: ENSAFE JOB: NASM094

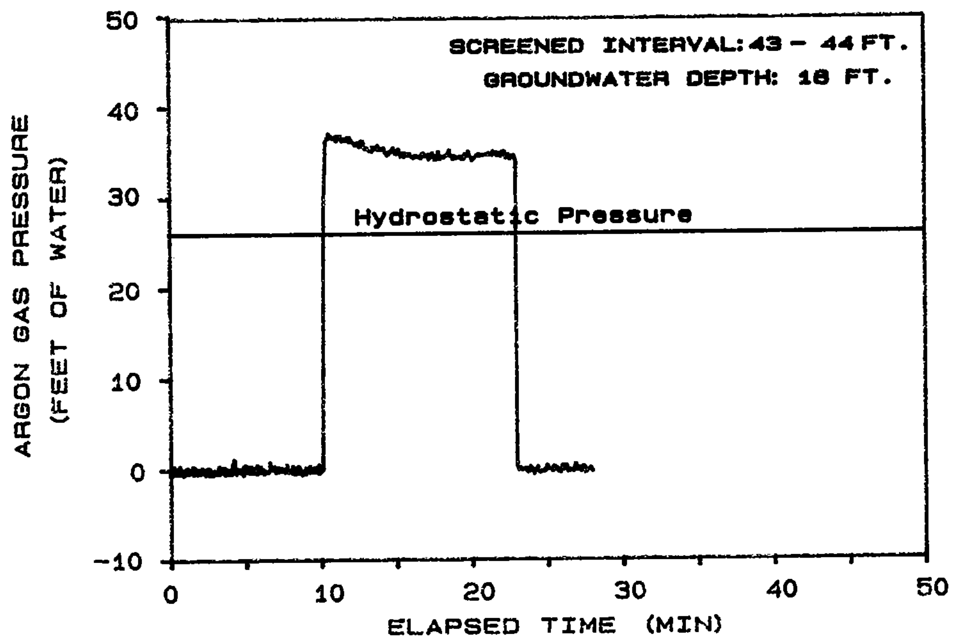
DATE: 06-01-1995 LOCATION: SWMU7 ST24

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

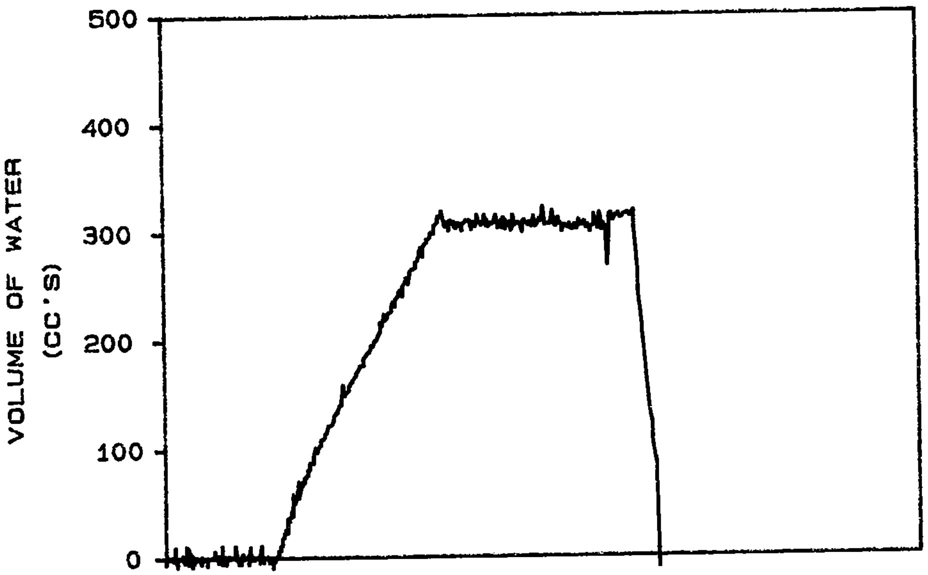
SAMPLE #: 07GH2544

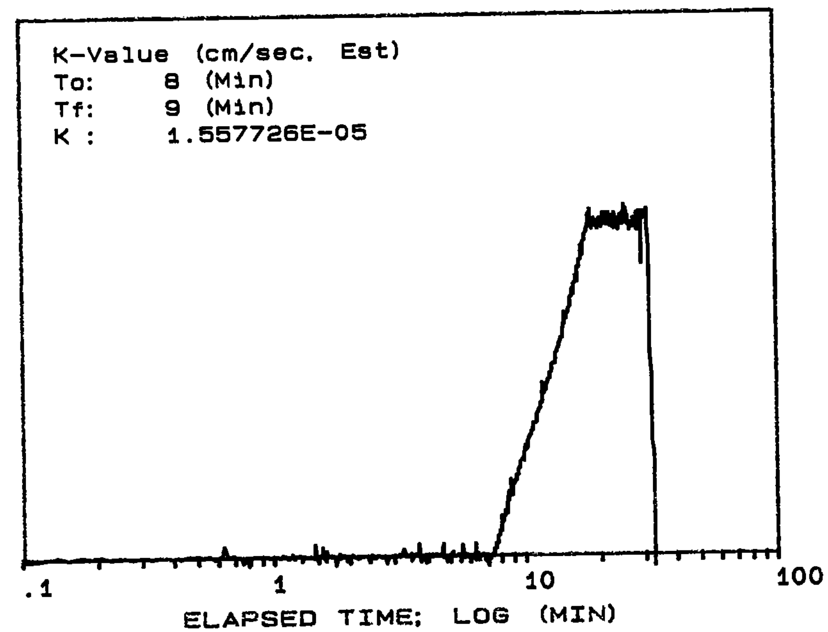
CLIENT: ENSAFE JOB: NASM094

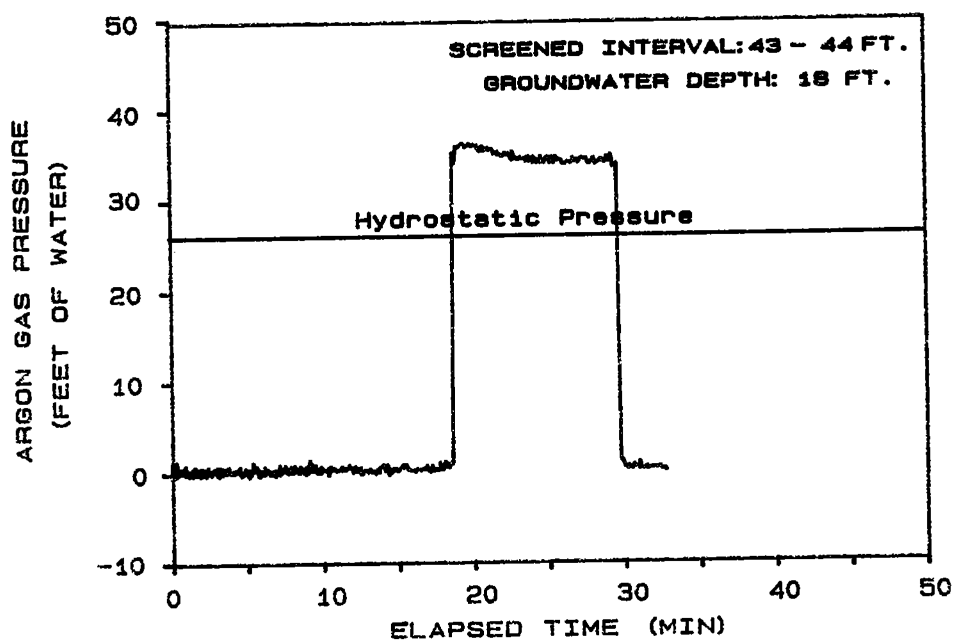
DATE: 06-01-1995 LOCATION: SWMU7 ST25

PERFORMED BY:

SUBSURFACE TECHNOLOGY







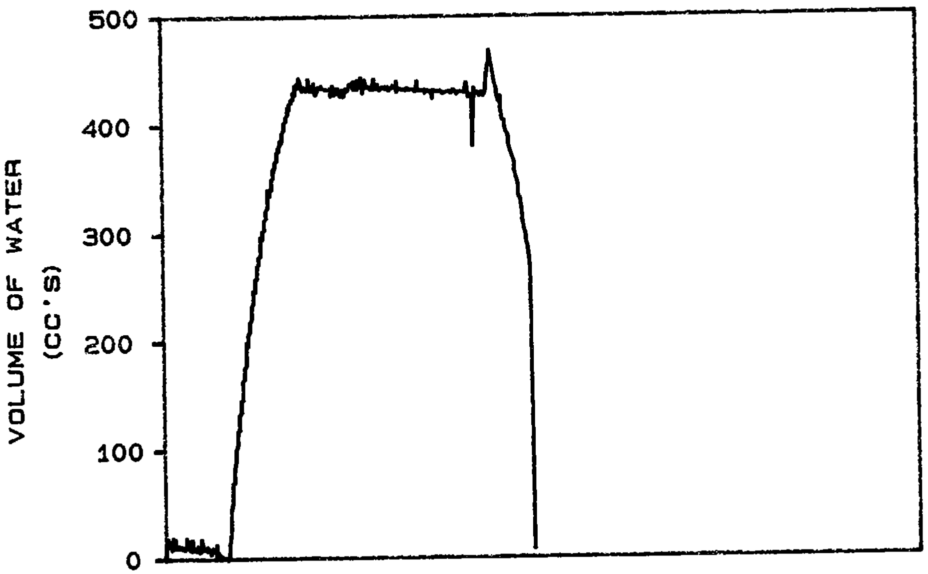
GS-1 SAMPLE PLOT

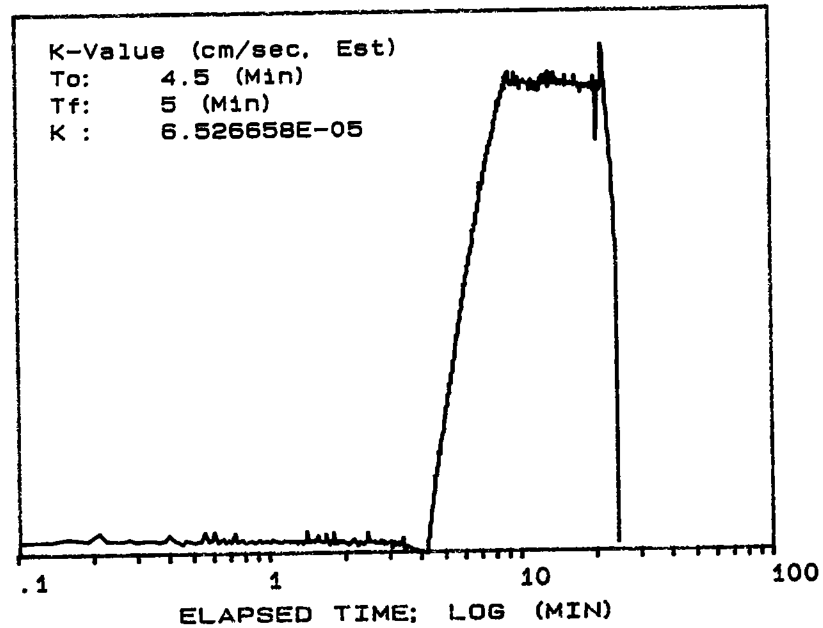
SAMPLE #: 07GH2644

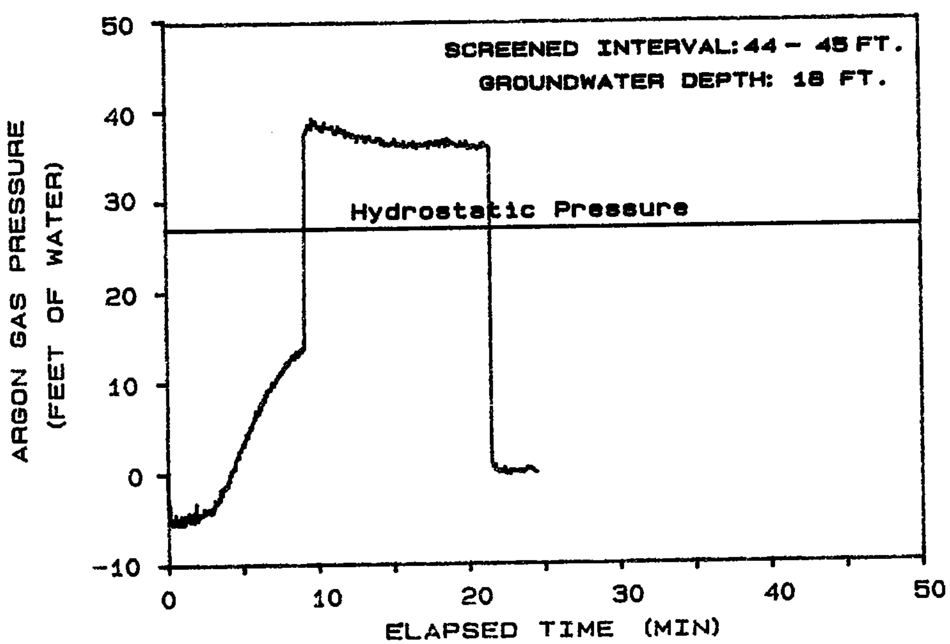
CLIENT: ENSAFE JOB: NASM094
DATE: 06-01-1995 LOCATION: SWMU7 ST26

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

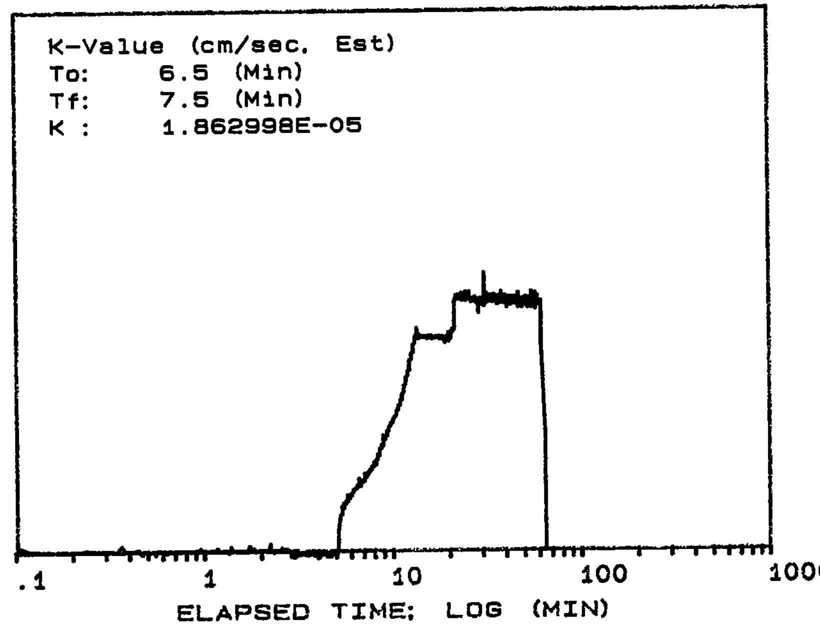
SAMPLE #: 07GH2745

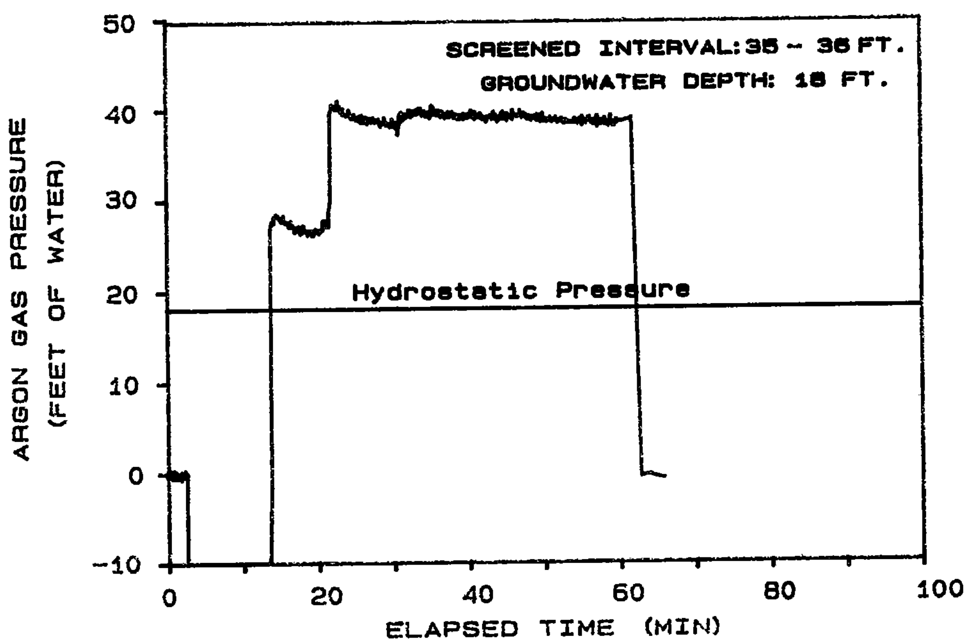
CLIENT: ENSAFE JOB: NASM094

DATE: 06-01-1995 LOCATION: SWMU07 ST2

PERFORMED BY:

SUBSURFACE TECHNOLOGY





GS-1 SAMPLE PLOT

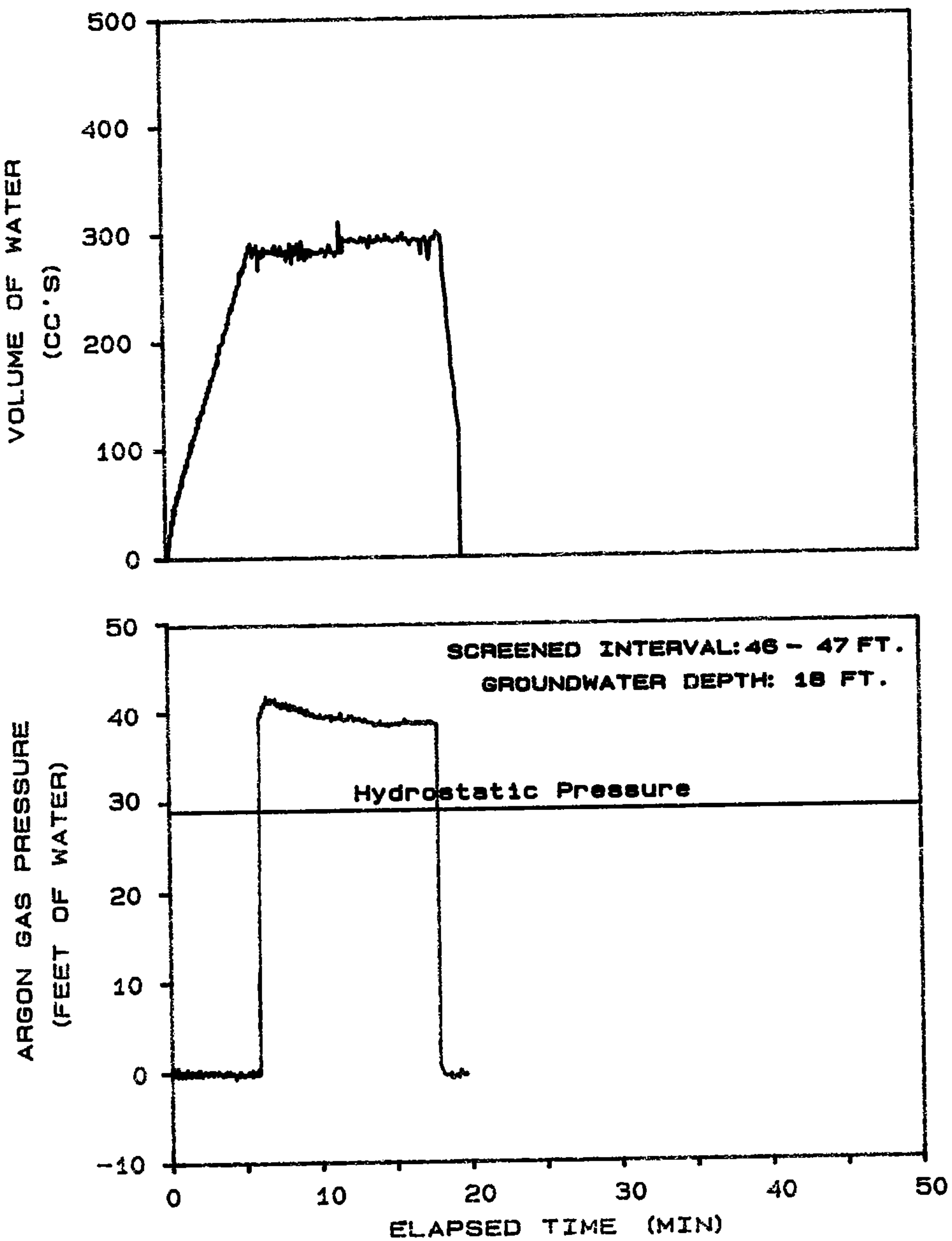
SAMPLE #: 07GH2936

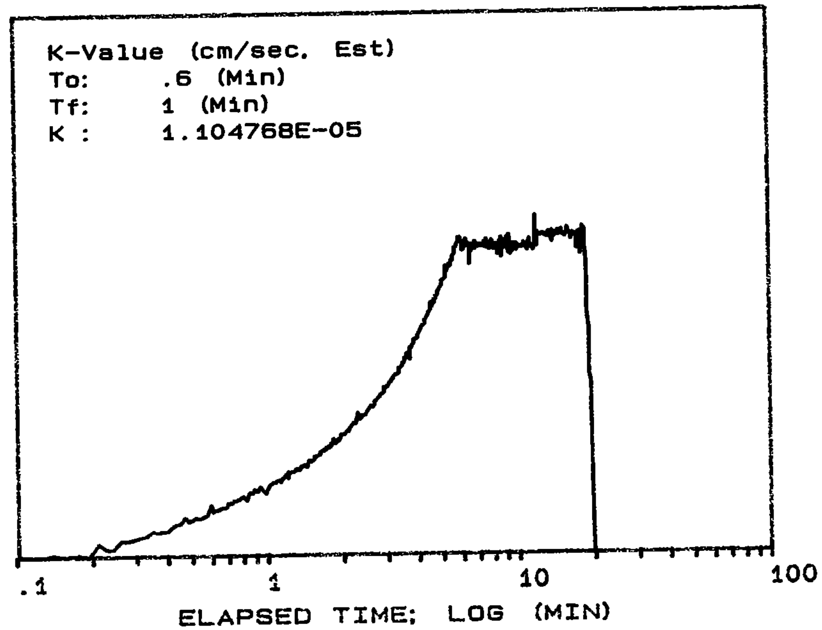
CLIENT: ENSAFE JOB: NASM094

DATE: 06-02-1995 LOCATION: SWMU07 ST2

PERFORMED BY:

SUBSURFACE TECHNOLOGY





GS-1 SAMPLE PLOT

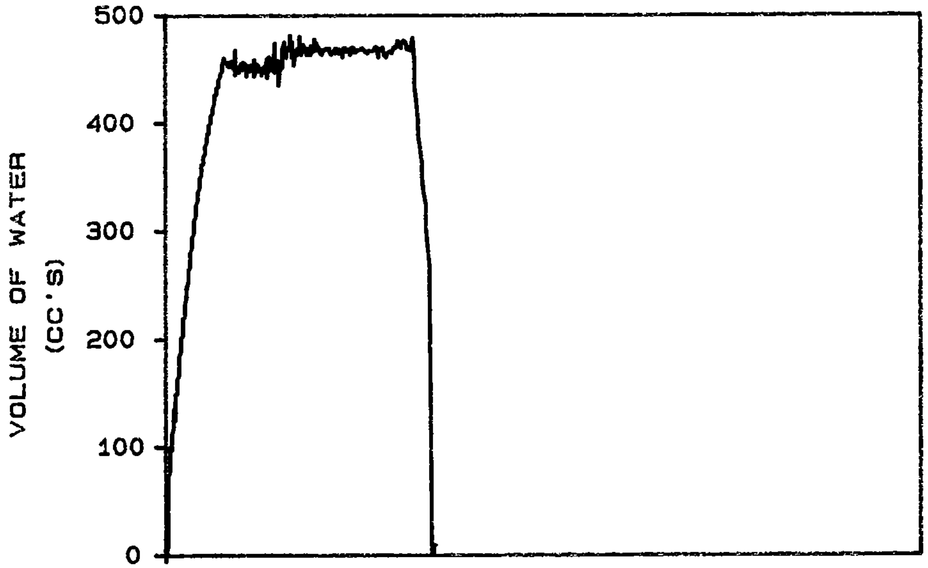
SAMPLE #: 07GH3047

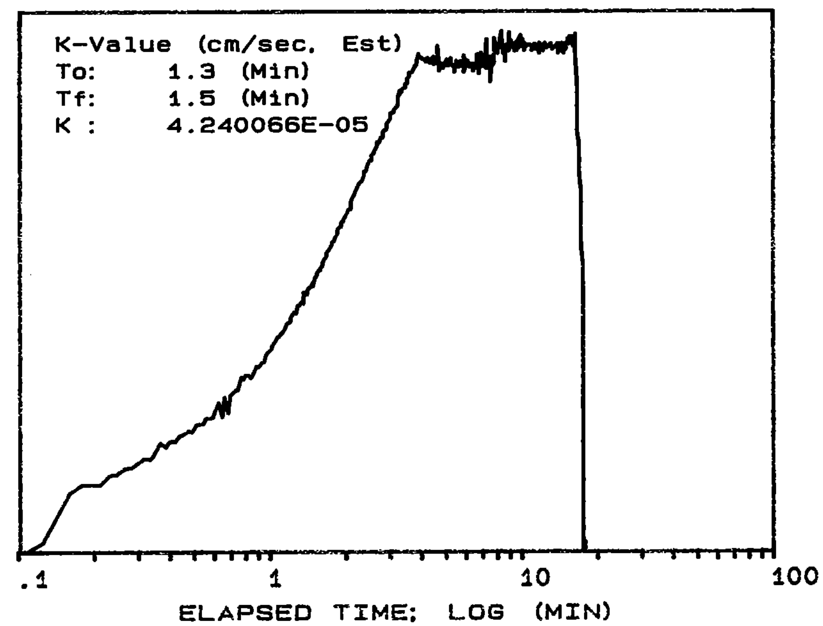
CLIENT: ENSAFE JOB: NASM094

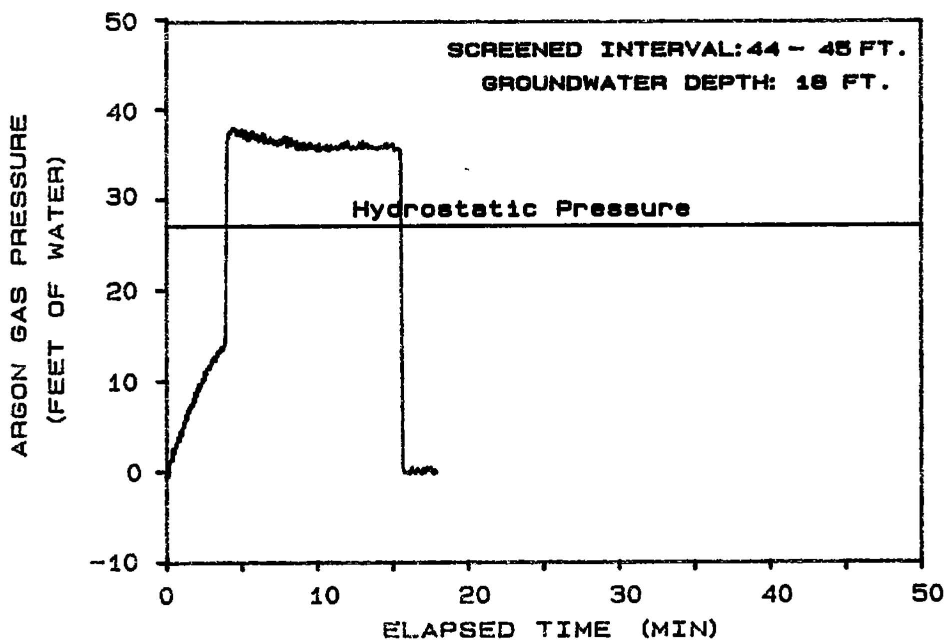
DATE: 05-31-1995 LOCATION: SWMU7 ST30

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

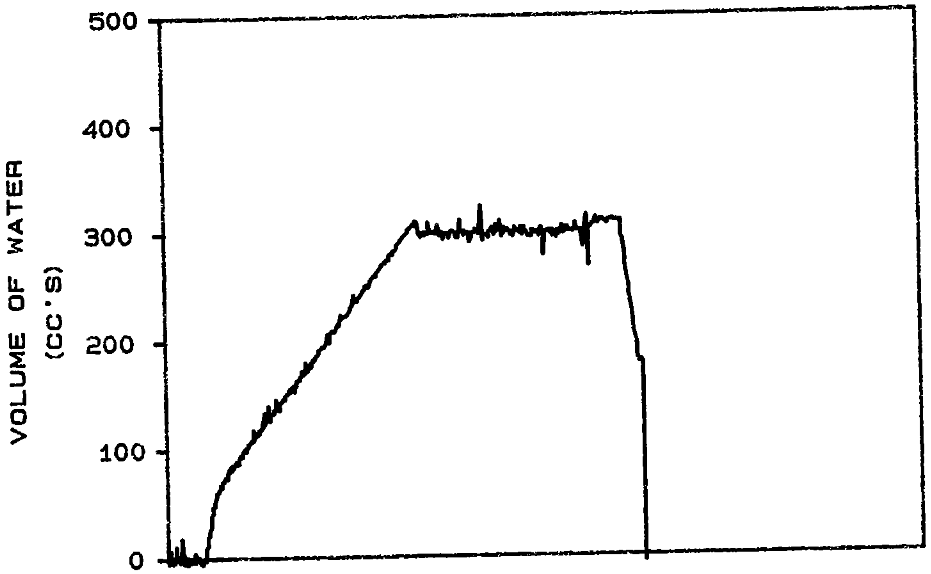
SAMPLE #: 07GH3145

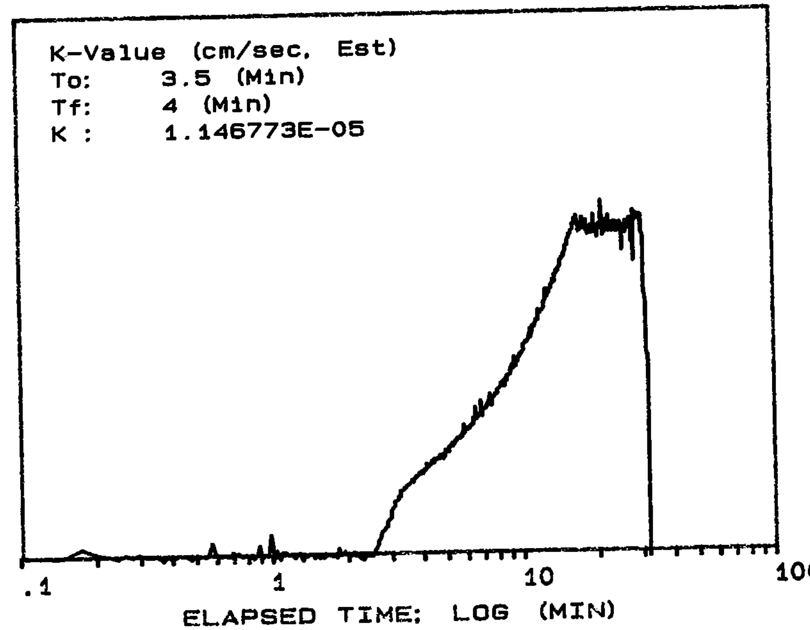
CLIENT: ENSAFE JOB: NASM094

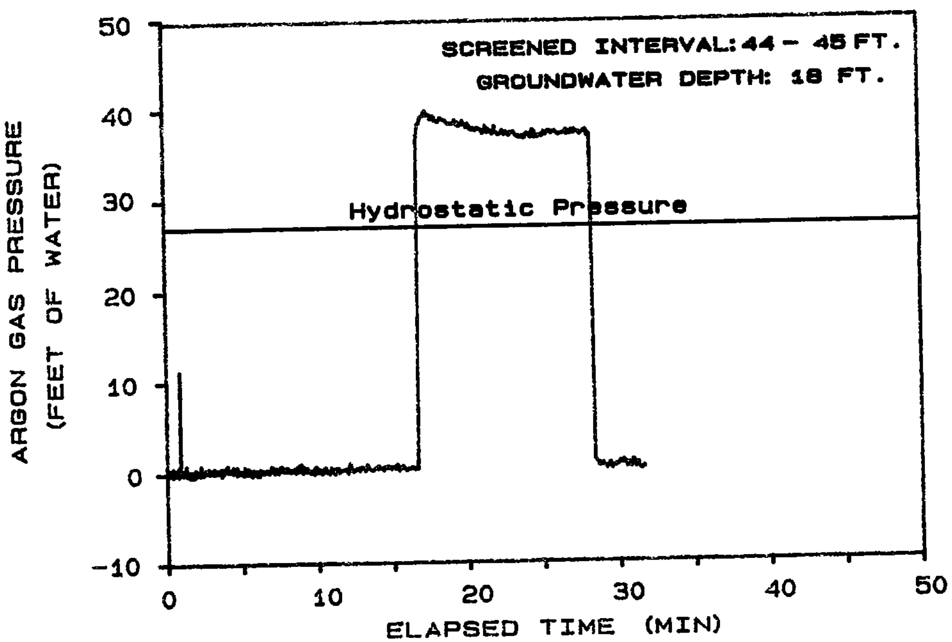
DATE: 05-31-1995 LOCATION: SWMU7 ST31

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

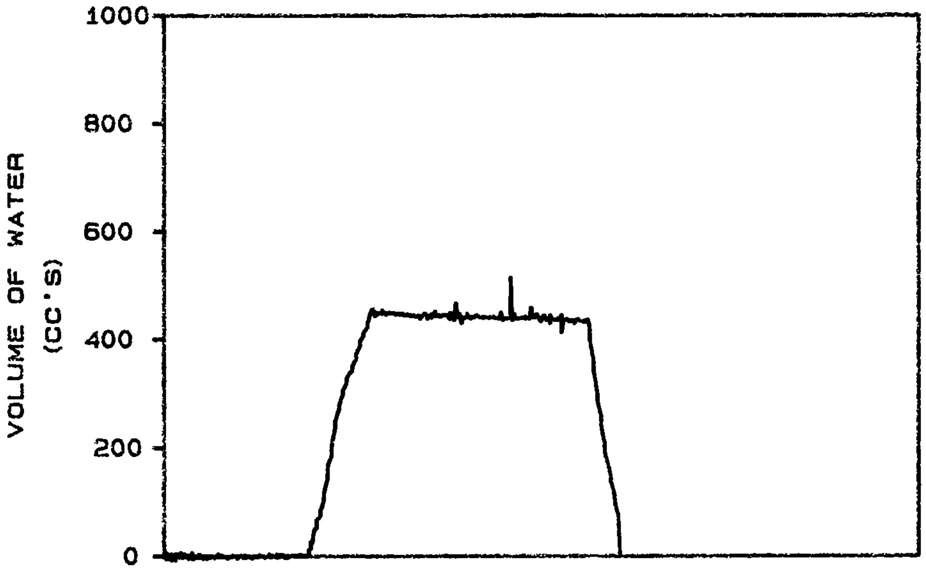
SAMPLE #: 07GH3245

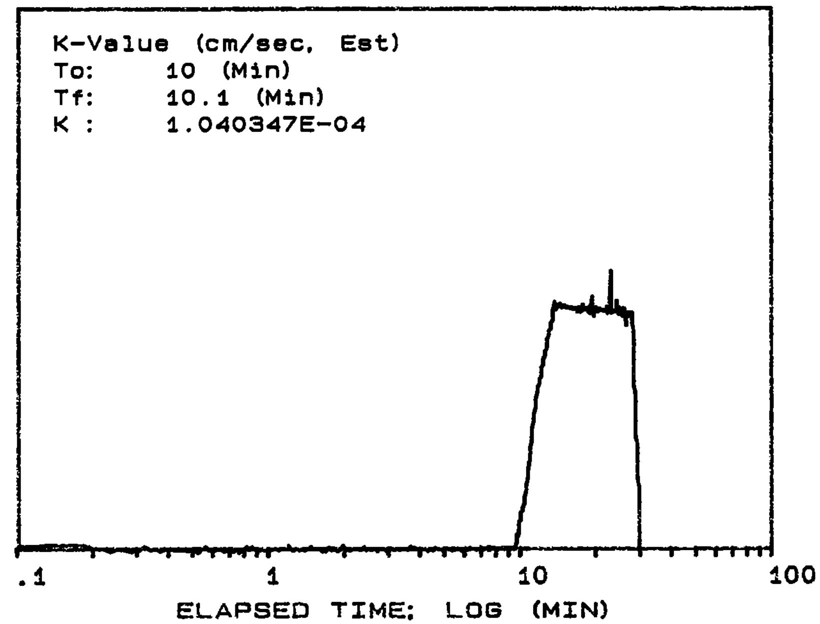
CLIENT: ENSAFE　　JOB: NASM094

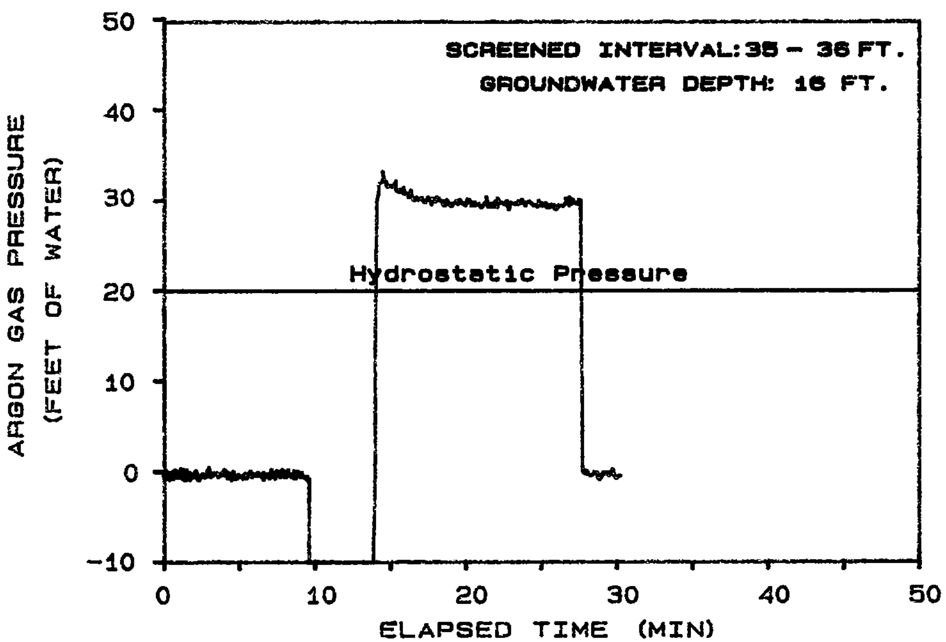
DATE: 05-31-1995　　LOCATION: SWMU7 ST32

PERFORMED BY:

SUBSURFACE TECHNOLOGY







GS-1 SAMPLE PLOT

SAMPLE #: 07GH3336

CLIENT: ENSAFE JOB: NASM094
DATE: 06-01-1995 LOCATION: SWMU7 ST33

PERFORMED BY:

SUBSURFACE TECHNOLOGY

Appendix E

Summary Analytical Tables

- Stratigraphic Testing Borings
- DPT Investigations
- Organics Detected in Groundwater by Well
- Inorganics Detected in Groundwater by Well

Table E-1
VOC Results from Stratigraphic Test Borings
SWMU 7/Apron Area (μg/kg)

Sample I.D.	TCE	Carbon Tet	1,1,1-TCA	1,1-DCA	C 1,2-DCE	PCE
007SB001-13 (L)						
-17 (L)	12					
-41 (F)	2.6 J					
-71(F)						
-83 (F)	4 J	3.3 J				
-137 (C)						
-178 (C)						
SSL	20	30	900	11000	200	40
SSL Exceedance	no	no	no	no	no	no
007SB002-17 (L)						
-40 (F)						
-78 (F)						
-80 (F)						
-99 (C)			108			
-123 (C)			7.3			
-160 (C)						
SSL	20	30	900	11000	200	40
SSL Exceedance	no	no	no	no	no	no
SB03-28 (L)						
-34 (F)						
-81 (F)						
-145 (C)			18.3			
-184 (C)			3.6 J			
SSL	20	30	900	11000	200	40
SSL Exceedance	no	no	no	no	no	no
007SB004-13 (L)	1.6 J			3.2 J	2.14 J	

Table E-1
VOC Results from Stratigraphic Test Borings
SWMU 7/Apron Area ($\mu g/kg$)

Sample I.D.	TCE	Carbon Tet	1,1,1-TCA	1,1-DCA	C 1,2-DCE	PCE
-25 (L)						
-35 (F)						2.2 J
-69 (F)			5.7			
-88 (C)						
-107 (C)			9.3			
-160 (C)						
SSL	20	30	900	11000	200	40
SSL Exceedance	no	no	no	no	no	no

Notes:
TCE — Trichloroethene
Carbon Tet — Carbon Tetrachloride
1,1,1-TCA — 1,1,1 Trichloroethane
1,1-DCE — 1,1-Dichloroethane
C 1,2-DCE — cis-1,2-Dichloroethene
PCE — Tetrachlorethene
L — Loess
F — Fluvial Deposits
C — Cockfield Formation
J — denotes estimated concentration. Compound present below quantitation limit.
SSL — Transfer from soil-to-groundwater screening level from Risk Based Concentration Table (December 22, 1997, USEPA Region III RBC Memo).

Table E-2
DPT Sampling Results for VOCs
SWMU 7/Apron Area

Sample Location	Sample ID	Soil or Water	Depth (ft. bls)	Concentration (ppb)	Compound
First DPT Sampling Results - 11/20/94 through 12/07/94					
MW	GM-9	W	50	7.3	TCE
7-1	7SG0110	S	10	ND/Dup ND	
	7GH0138	W	38	ND/Dup - 3	Chloroform
7-2	7SG0212	S	12	ND	
	7SG0223	S	23	ND/Dup ND	
	7GH0236	W	36	ND	
7-3	7SG0312	S	12	ND	
	7SG0322	S	22	ND	
	7GH0334	W	34	ND	
7-4	7SG0412	S	12	ND	
	7SG0422	S	22	ND	
	7GH0435	W	35	ND	
7-5	7SG0512	S	12	ND	
	7SG0522	S	22	ND	
	7GH0535	W	35	ND	
7-7	7SG0712	S	12	ND	
	7SG0722	S	22	ND	
	7GH0736	W	36	ND	
7-8	7SG0812	S	12	ND	
	7SG0822	S	22	ND	
	7GH0836	W	36	ND	
7-9	7SG0910	S	10	ND	
	7SG0926	S	26	ND	
	7GH0940	W	40	ND	
7-10	7SG1006	S	6	ND/Dup - 4	Toluene
	7GH1039	W	39	ND/Dup - 70	Acetone
				ND/Dup - 1	TCE
7-11	7SG1107	S	7	ND/Dup - 31	Acetone
				ND/Dup- 2	Toluene
	7GH1143	W	43	NONE/Dup - 4	Acetone
7-12	7SG1207	S	7	ND/Dup - 7	Toluene
	7GH1242	W	42	20/Dup - 11	TCE
7-13	7SG1307	S	7	ND	
	7GH1339	W	39	ND/Dup - 22	Acetone

Table E-2
DPT Sampling Results for VOCs
SWMU 7/Apron Area

Sample Location	Sample ID	Soil or Water	Depth (ft. bls)	Concentration (ppb)	Compound
7-14	7SG1407	S	7	ND	
	7GH1442	W	42	ND	
7-15	7SG1507	S	7	ND	
	7GH1542	W	42	5.4	c-1,2-DCE
				10	1,1-DCA
				8.8	1,1-DCE
				6.1	TCE
7-16	7SG1607	S	7	ND	
	7GH1636	W	36	17.4	c-1,2-DCE
				11.1	PCE
7-17	7GH1741	W	41	ND	
7-18	7SG1807	S	7	ND	
	7GH1841	W	41	ND	
7-19	7GH1942	W	42	48.2	1,1-DCA
				43.7	1,1-DCE
				9	TCE
7-20	7GH2038	W	38	ND	
7-21	7GH2136	W	36	200	c-1,2-DCE
				320	1,1-DCA
7-22	7GH2243	W	43	5.25/Dup - 4.01	1,1-DCA
				4.23/Dup - 3.69	TCE
7-23	7GH2343	W	43	ND	
Second DPT Sampling Results - 5/31/95 - 6/2/95					
7-24	7S002412	S	12	ND	
	7G002437	W	37	ND/Dup- 4	1,1 DCA
				ND/Dup - 1	1,1 DCE
				ND/Dup - 1	Methylene Chloride
7-25	7S002512	S	12	ND/Dup ND	
	7G002544	W	44	ND/Dup ND	
7-26	7S002612	S	12	ND	
	7G002644	W	44	ND	
7-27	7S002712	S	12	ND/Dup ND	
	7G002745	W	45	ND	

Table E-2
DPT Sampling Results for VOCs
SWMU 7/Apron Area

Sample Location	Sample ID	Soil or Water	Depth (ft. bls)	Concentration (ppb)	Compound
7-28	7S002812	S	12	ND/Dup ND	
7-29	7S002912	S	12	ND	
	7G002936	W	36	12.6/Dup 17	TCE
				8/Dup 7	PCE
7-30	7S003012	S	12	ND	
	7G003047	W	47	7.9	TCE
				120	PCE
7-31	7S003112	S	12	ND	
	7G003145	W	45	ND	
7-32	7S003212	S	12	ND	
	7G003245	W	45	4.9	m,p-Xylenes
				8.5	Trichlorofluorom
7-33	7S003312	S	12	ND	
	7G003336	W	36	9.4	1,1-DCE
				8.2	1,1-DCA
Third DPT Sampling Results - 11/10/95 - 12/08/95					
7-34	7G003445	G	45	ND	
7-35	7G003549	G	49	79.7	1,1-DCE
				9.92	c-1,2-DCE
				117	TCE
				44.2	1,2-DCA
				31.9	Bromochloromet
				10.3	Carbon Tet.
7-36	7G003658	G	58	6.1/DUP ND	Dichlorodifluoromethane
					1,2-DCE
				ND/DUP - 28	
7-37	7G003760	G	60	ND	
7-38	7G003849	G	49	ND	
7-39	7G003934	G	34	6.5	TCE
7-40	7G004042	G	42	1.7 J/Dup 1 J	1,1-DCA

Table E-2
DPT Sampling Results for VOCs
SWMU 7/Apron Area

Sample Location	Sample ID	Soil or Water	Depth (ft. bls)	Concentration (ppb)	Compound
7-41	7G004143	G	43	1.7 20	1,2-DCE TCE
7-42	7G004240	G	40	15/Dup ND 6.7/Dup ND 2.8/Dup ND 6.4/Dup 7.7	Dichlorofluorom. Methylene Chloride Chloroform Carbon Tet.
7-43	7G004346	G	46	ND	
7-44	7G004446	G	46	1.4	TCE
7-45	7G004545	G	45	ND/DUP 61	Acetone
7-46	7G004646	G	46	ND	
7-47	7G004746	G	46	5	TCE
7-48	7G004845	G	45	11.2	1,2-DCA
7-49	7G004934	G	34	8.1/Dup 7	TCE
7-50	7G005061	G	61	ND/Dup 16	MEK
7-51	7G005154	G	54	ND	
7-52	7G005265	G	52	ND	
Fourth DPT (Geoprobe) Sample Results 2/23/96-2/27/96 and 10/29/96					
7-53	007G005364	G	64	ND	
7-54	007G005458	G	58	ND	
7-55	007G005560	G	60	ND	
7-56	007G005650	G	50	ND	
7-57	007G005757	G	57	6.0/Dup 5.8 42.6/Dup 56.5 128/Dup 149	Choloroform PCE TCE
7-58	007G005872	G	58	7.4 3.3 16	Carbon Tet. Chloroform TCE

Table E-2
DPT Sampling Results for VOCs
SWMU 7/Apron Area

Sample Location	Sample ID	Soil or Water	Depth (ft. bls)	Concentration (ppb)	Compound
7-59	007G005965	G	65	1.0 1.1 13.8 47.3	Carbon Tet. Chloroform TCE c-1,2-DCE
7-60	007G006079	G	79	ND	

Table E-2
DPT Sampling Results for VOCs
SWMU 7/Apron Area

Sample Location	Sample ID	Soil or Water	Depth (ft. bls)	Concentration (ppb)	Compound
7-61	007G006157	G	57	ND	
	007G006167	G	67	ND	
	007G006176	G	76	ND	
Fifth (Rotasonic) Sample Results: 2/4/97 through 2/24/97					
7-62	007G006264 (LF)	G	64	62 J	Acetone
				179	Acrylonitrile
				653	Benzene
				60.2	Chloromethane
				49.6	Ethylbenzene
				29.5	Styrene
				169	Toluene
				7.69	TCE
				70.2	Xylenes
7-63	007G006345 (UF)	G	45	3.2 J	cis 1,2-DCE
	007G006358 (MF)		58	ND	
7-64	007G006445 (UF)	G	45	37.5	Benzene
				2.5 J	1,1-DCE
				4.7 J	Ethylbenzene
				2.1 J	Styrene
				1.8 J	PCE
				18.6	Toluene
				82.1	TCE
				6.4	Xylenes
				1.6 J	cis-1,2,-DCE
	007G006455 (MF)[a]	G	55	188	Acetone
	007G006467 (LF)	G	67	9.8	Chloroform
				18.8	TCE
7-65	007G006548 (MF)	G	48	50 J	Acetone
	007G006567 (LF)	G	67	ND	
7-66	007G006650 (MF)	G	50	2.6 J	1,1-DCA
				3.7 J	1,1-DCE
				1.7 J	TCE
				1.6 J	c 1,2-DCE
	007G006663 (LF)	G	63	0.9 J	1,1-DCE

Table E-2
DPT Sampling Results for VOCs
SWMU 7/Apron Area

Sample Location	Sample ID	Soil or Water	Depth (ft. bls)	Concentration (ppb)	Compound
7-67	007G006746 (UF)	G	46	ND/Dup ND	
	007G006751 (MF)	G	51	ND	
	007G006756 (MF)	G	56	ND	
	007G006760 (LF)	G	60	ND	
	007G006765 (LF)	G	65	ND	
	007G006772 (LF)	G	72	538 2.1 1.7 J	Acetone Chloroform TCE
7-68	007G006848(UF)	G	48	200 1.9 3.2 2.6	Acetone 1,1-DCA 1,1-DCE TCE
	007G006853 (UF)	G	53	50.9 J 2.7 5.1 3.7	Acetone 1,1-DCA 1,1-DCE TCE
	007G006858 (MF)	G	58	1380 2.4 4.3 1.6 J	Acetone 1,1-DCA 1,1-DCE TCE
	007G006864 (MF)	G	64	562 17.4 27.7 2.0 J	Acetone Carbon Tet. Chloroform 1,1-DCE
	007G006869 (MF)	G	69	23.2 22.4 2.3 J 1.2 J	Carbon Tet. Chloroform 1,1-DCE TCE
	007G006873 (LF)	G	73	15.2 23.3 8.2 5.6	Carbon Tet. Chloroform TCE cis-1,2-DCE
	007G006878 (LF)	G	78	6.5 8.1 6.4 5.12	Carbon Tet. Chloroform TCE cis-1,2-DCE
	007G006883 (LF)	G	83	594 1.3 J 4.1 J 1.3 J	Acetone Carbon Tet. Chloroform TCE
	007G006888 (LF)	G	88	1.4 J 3.9 J	Carbon Tet. Chloroform

Table E-2
DPT Sampling Results for VOCs
SWMU 7/Apron Area

Sample Location	Sample ID	Soil or Water	Depth (ft. bls)	Concentration (ppb)	Compound
7-69	007G006960 (MF)	G	60	5.1/Dup 4.8 J	Benzene
				199/Dup 185	Carbon Tet.
				180/Dup 170	Chloroform
				36.5/Dup 34.2	1,1-DCA
				183/Dup 163	1,1-DCE
				1160/Dup 1310	TCE
				29.2/Dup 27.2	cis-1,2-DCE
	007G006990 (LF)	G	90	1.6 J	TCE
7-70	007G007046 (UF)	G	46	1.9 J	Chloroform
				3.2 J	1,1-DCA
				10.7	1,1-DCE
				16.9	TCE
	007G007068 (MF)	G	68	47.4	Chloroform
				4.3 J	1,1-DCE
				190	TCE
	007G007088 (LF)	G	88	3.5 J	Carbon Tet.
				11.3	Chloroform
				1.0 J	1,1-DCE
				38.9	TCE
7-71	007G007146 (UF)	G	46	1020	Acetone
				1.7 J	1,1-DCA
	007G007168 (MF)	G	68	121	Carbon Tet.
				60.8	Chloroform
				2.7	1,1-DCE
				422	TCE
	007G007188 (LF)	G	88	34.3	Carbon Tet.
				15.9	Chloroform
				2.6	1,1-DCE
				14	TCE
7-72	007G007246 (UF)	G	46	4.1	1,1-DCA
				8.7	1,1-DCE
				16.1	TCE
	007G007268 (MF)	G	68	10.3	Carbon Tet.
				30.6	Chloroform
				1.6J	1,1-DCE
				122	TCE
	007G007290 (LF)	G	90	197	Acetone
				28.5	Carbon Tet.
				21.1	Chloroform
				2.1 J	1,1-DCE
				8.7	TCE
7-73	007G007368 (MF)	G	68	164	Acetone
				2.1 J	Chloroform
				15.3	TCE

Table E-2
DPT Sampling Results for VOCs
SWMU 7/Apron Area

Sample Location	Sample ID	Soil or Water	Depth (ft. bls)	Concentration (ppb)	Compound
	007G007390 (LF)	G	90	44 J	Acetone
7-74	007G007468 (MF)	G	68	4.3 J 1.4 J 47.4	Chloroform 1,1-DCE TCE
	007G007491 (LF)	G	91	33 J 1.2 J	Acetone TCE
7-75	007G007559 (UF)	G	59	1.4 J 1.4 J	Benzene Toluene
7-76	007G007660 (UF)	G	60	ND	
	007G007680 (LF)	G	80	9.8	TCE
7-77	007G007768 (LF)[a]	G	68	4.3 J 9.7 J 22	Chloroform PCE TCE
7-78	007G007868 (LF)	G	68	11.5 2.3 J	Chloroform TCE
7-79	007G007967 (MF)	G	67	7.2 3.5 J 10.2 61.2	Chloroform 1,1-DCA 1,1-DCE TCE
7-80	007G008066 (MF)	G	66	3.3 J 14.2 26.2	Chloroform 1,1-DCE TCE
	007G008087 (LF)	G	87	ND	

Notes:
a — Water sample very turbid and air bubbles reported in VOA vials.
J — Compound was detected below the method reporting limit; value estimated.
ND — Non detect
ppb — parts per billion

Sample locations are shown on the figures presented in Sections 3 and 4 and Appendix A.

Table E-3
SWMU 7/Apron Area
Organics Detected in Groundwater by Well ($\mu g/L$)

Well ID	Constituent	RBC[a]	MCL[b]	Initial[c]	Intermediate[d]	Event 1[e]	Event 2[f]	Event 3[g]
007G01LF	1,1-Dichloroethane	810	DNE	2 J	3 J	5 J	2 J	10 U
	1,1-Dichloroethene	0.044	7	3 J	4 J	9 J	3 J	10 U
	1,2-Dichloroethene (total)	55	70	2 J	2 J	2 J	2 J	10 U
	Carbon tetrachloride	0.16	5	4 J	10	10 U	6 J	10
	Chloroform	0.15	100	2 J	2 J	10 U	2 J	10 U
	Trichloroethene	1.6	5	6 J	8 J	4 J	8 J	10
007G01LS	1,1-Dichloroethane	810	DNE	46	79	NS	NS	NS
	1,1-Dichloroethene	0.044	7	1 J	4 J	NS	NS	NS
	1,2-Dichloroethane	0.12	5	3 J	4 J	NS	NS	NS
	1,2-Dichloroethene (total)	55	70	19	34	NS	NS	NS
	1,2-Dichloropropane	0.16	5	1 J	2 J	NS	NS	NS
	2-Hexanone	DNE	DNE	25 J	10 U	NS	NS	NS
	Benzene	0.36	5	7 J	8 J	NS	NS	NS
	Tetrachloroethene	1.1	5	10 U	2 J	NS	NS	NS
	Trichloroethene	1.6	5	9 J	19	NS	NS	NS
007G01UC	Acetone	3,700	DNE	10 U	10 U	84 J	NS	10 U
007G01UF	1,1-Dichloroethane	810	DNE	18	26	75	45	30
	1,1-Dichloroethene	0.044	7	3 J	4 J	19	9 J	6 J
	1,2-Dichloroethene (total)	55	70	5 J	6 J	14	10	6 J
	1,2-Dichloropropane	0.16	5	10 U	10 U	2 J	2 J	10 U
	Tetrachloroethene	1.1	5	8 J	9 J	6 J	8 J	9 J
	Trichloroethene	1.6	5	8 J	11	19	14	10
007G02UC	4-Methyl-2-Pentanone (MIBK)	2,900	DNE	10 U	10 U	2 J	NS	10 U
	Carbon disulfide	1,000	DNE	10 U	10 U	1 J	NS	10 U
007G03LF	1,2-Dichloroethane	0.12	5	10 U	10 U	10 U	1 J	10 U
	2-Butanone (MEK)	1,900	DNE	10 UJ	10 U	10 U	20 J	10 U
	Acetone	3,700	DNE	78	10 U	10 U	10 UJ	10 U
	Carbon tetrachloride	0.16	5	12	16	19	20 J	19
	Chloroform	0.15	100	8 J	8 J	10	11	10
	Tetrachloroethene	1.1	5	1 J	2 J	2 J	4 J	3 J
	Trichloroethene	1.6	5	63	73	98	97	78
007G03LS	Acetone	3,700	DNE	120	10 U	NS	NS	NS
	BEHP	4.8	DNE	2 J	NS	NS	NS	NS
007G03UC	Acetone	3,700	DNE	22 U	16	29 U	NS	10 U
	Chloromethane	1.4	DNE	10 U	10 U	3 J	NS	10 U
007G03UF	Acetone	3,700	DNE	12	39	5 U	10 UJ	10 U
	Carbon disulfide	1,000	DNE	10 U	3 J	10 U	10 U	10 U

Table E-3
SWMU 7/Apron Area
Organics Detected in Groundwater by Well (μg/L)

Well ID	Constituent	RBC[a]	MCL[b]	Initial[c]	Intermediate[d]	Event 1[e]	Event 2[f]	Event 3[g]
007G04LF	1,1-Dichloroethene	0.044	7	10 U	50 U	2 J	10 U	2 J
	1,2-Dichloroethene (total)	55	70	10 U	50 U	2 J	10 UJ	2 J
	Acetone	3,700	DNE	83	50 U	95 J	10 UJ	10 U
	Carbon tetrachloride	0.16	5	10 U	9 J	10 U	13 J	9 J
	Chloroform	0.15	100	10 U	50 U	10 U	3 J	2 J
	Methylene chloride	4.1	5	10 U	50 U	1 J	10 U	10 U
	Tetrachloroethene	1.1	5	10 U	26 J	61	6 J	31
	Trichloroethene	1.6	5	2 J	390	1,100 D	160	620 D
007G04UC	Acetone	3,700	DNE	10 U	10 J	NS	NS	10 U
	BEHP	4.8	DNE	3 J	NS	NS	NS	NS
007G04UF	Acetone	3,700	DNE	30	18 J	240	10 UJ	10 U
	Methylene chloride	4.1	5	10 U	10 U	2 J	10 U	10 U
	Trichloroethene	1.6	5	3 J	1 J	20 U	10 U	10 U
007G05LF	1,2-Dichloroethane	0.12	5	4 J	4 J	4 J	10 U	3 J
	Acetone	3,700	DNE	10 U	11 J	10 U	10 U	10 UJ
	Carbon tetrachloride	0.16	5	6 J	8 J	7 J	11	6 J
	Chloroform	0.15	100	4 J	5 J	10 U	5 J	5 J
	Tetrachloroethene	1.1	5	10 U	1 J	1 J	1 J	1 J
	Trichloroethene	1.6	5	22	28	31	38	27 J
007G05LS	Acetone	3,700	DNE	20	10 U	10 U	NS	NS
	Ethylbenzene	1,300	700	10 U	1 J	10 U	NS	NS
007G05UC	Acetone	3,700	DNE	49	10 UJ	10 U	NS	10 U
	Dimethyl phthalate	370,000	DNE	1 J	NS	NS	NS	NS
	Toluene	750	1,000	10 U	10 U	1 J	NS	10 U
007G05UF	2-Butanone (MEK)	1,900	DNE	10 U	10 U	1 J	10 UJ	10 U
	Acetone	3,700	DNE	10 U	98	39 U	10 UJ	10 U
007G06LF	Acetone	3,700	DNE	5 J	5 J	51 UJ	10 UJ	10 U
	Tetrachloroethene	1.1	5	1 J	1 J	2 J	2 J	3 J
	Trichloroethene	1.6	5	2 J	2 J	2 J	2 J	3 J
007G06LS	Acetone	3,700	DNE	11	10 U	10 U	NS	NS
	Phenol	22,000	DNE	10 U	NS	21	NS	NS
007G06UC	Acetone	3,700	DNE	10 U	10 U	24	NS	180 J
007G06UF	Acetone	3,700	DNE	59	320	10 U	10 U	10 U
007G07LF	1,1-Dichloroethane	810	DNE	2 J	1 J	NS	10 U	10 U
	1,1-Dichloroethene	0.044	7	1 J	1 J	NS	10 U	10 U
	Acetone	3,700	DNE	33	10 UJ	NS	10 U	10 U
	Carbon disulfide	1,000	DNE	1 J	10 U	NS	10 U	10 U
	Carbon tetrachloride	0.16	5	10 U	1 J	NS	10 U	10 U
	Tetrachloroethene	1.1	5	3 J	3 J	NS	8 J	6 J
	Trichloroethene	1.6	5	6 J	6 J	NS	7 J	6 J
007G07LS	Acetone	3,700	DNE	12	40 J	10 U	NS	NS
007G07UC	Acetone	3,700	DNE	10	21 J	150	NS	10 U

Table E-3
SWMU 7/Apron Area
Organics Detected in Groundwater by Well (μg/L)

Well ID	Constituent	RBC[a]	MCL[b]	Initial[c]	Intermediate[d]	Event 1[e]	Event 2[f]	Event 3[g]
007G07UF	Acetone	3,700	DNE	10 U	25 J	10 U	10 U	10 U
	Vinyl chloride	0.019	2	2 J	2 J	10 U	10 U	10 U
	BEHP	4.8	DNE	1 J	NS	NS	NS	NS
007G08LF	1,1-Dichloroethane	810	DNE	4 J	4 J	100 U	5 J	10 U
	1,1-Dichloroethene	0.044	7	7 J	6 J	100 U	9 J	10
	1,2-Dichloroethene (total)	55	70	2 J	1 J	100 U	2 J	10 U
	Acetone	3,700	DNE	10 U	10 UJ	1,200	10 U	10 U
	Trichloroethene	1.6	5	7 J	8 J	100 U	9 J	9 J
007G08UC	1,1-Dichloroethane	810	DNE	1 J	10 U	10 U	NS	10 U
	1,2-Dichloroethane	0.12	5	1 J	10 U	10 U	NS	10 U
	1,2-Dichloroethene (total)	55	70	11	10 U	10 U	NS	10 U
	Acetone	3,700	DNE	18	10 UJ	10 U	NS	10 U
	Benzene	0.36	5	1 J	10 U	10 U	NS	10 U
	Bromomethane	8.7	DNE	1 J	10 U	10 U	NS	10 U
	Chloroform	0.15	100	2 J	10 U	10 U	NS	10 U
	Tetrachloroethene	1.1	5	5 J	10 U	10 U	NS	10 U
	Trichloroethene	1.6	5	4 J	10 U	10 U	NS	10 U
007G08UF	1,2-Dichloroethane	0.12	5	3 J	3 J	2 J	10 U	10 U
	Trichloroethene	1.6	5	1 J	1 J	10 U	2 J	10 U
007G09LF	1,1-Dichloroethane	810	DNE	10 U	10 U	2 J	10 U	2 J
	1,1-Dichloroethene	0.044	7	10 U	10 U	1 J	10 U	40
	1,2-Dichloroethane	0.12	5	10 U	2 J	10 U	10 U	10 U
	1,2-Dichloroethene (total)	55	70	10 U	10	34	16	10 U
	Benzene	0.36	5	10 U	10 U	2 J	10 U	10 U
	Chloroform	0.15	100	10 U	2 J	1 J	10 U	10 U
	Tetrachloroethene	1.1	5	10 U	6 J	15	12	33
	Trichloroethene	1.6	5	10 U	4 J	4 J	4 J	8 J
	Xylene (Total)	12,000	10,000	10 U	10 U	3 J	10 U	10 U
007G09LS	Acetone	3,700	DNE	10 U	14	10 U	NS	NS
	Chloroform	0.15	100	2 J	3 J	10 U	NS	NS
	Di-n-butylphthalate	3,700	DNE	10 U	NS	2 J	NS	NS
	TPH - DRO	100	DNE	NS	NS	120	NS	NS
007G09UC	Acetone	3,700	DNE	10 UJ	10 UJ	140 J	NS	10 U
007G09UF	1,1-Dichloroethane	810	DNE	1 J	10 U	NS	10 UJ	10 U
	Acetone	3,700	DNE	26	10 UJ	NS	10 UJ	10 U
	Bromomethane	8.7	DNE	1 J	10 U	NS	10 UJ	10 U
0GMG09MF[h]	1,1-Dichloroethene	0.044	7	10 U	1 J	10 U	NS	NS
	2-Butanone (MEK)	1,900	DNE	10 U	10 U	19	NS	NS
	Benzene	0.36	5	1 J	10 U	10 U	NS	NS
	Toluene	750	1,000	1 J	10 U	10 U	NS	NS
	Trichloroethene	1.6	5	4 J	7 J	4 J	NS	NS

Table E-3
SWMU 7/Apron Area
Organics Detected in Groundwater by Well (μg/L)

Well ID	Constituent	RBC[a]	MCL[b]	Initial[c]	Intermediate[d]	Event 1[e]	Event 2[f]	Event 3[g]
007G10LF[i]	4-Methyl-2-Pentanone (MIBK)	2,900	DNE	NS	NS	NS	2 J	10 U
	Carbon tetrachloride	0.16	5	NS	NS	NS	12	11
	Chloroform	0.15	100	NS	NS	NS	9 J	6 J
	Tetrachloroethene	1.1	5	NS	NS	NS	9 J	8 J
	Trichloroethene	1.6	5	NS	NS	NS	16	15
007G11LF[i]	1,2-Dichloroethene (total)	55	70	NS	NS	NS	3 J	10 U
	Carbon tetrachloride	0.16	5	NS	NS	NS	6 J	10 U
	Chloroform	0.15	100	NS	NS	NS	11	8 J
	TPH - DRO	100	DNE	NS	NS	NS	150	NS
	Tetrachloroethene	1.1	5	NS	NS	NS	120	27
	Trichloroethene	1.6	5	NS	NS	NS	230 D	57
007G13LF[i]	BEHP	4.8	DNE	NS	NS	NS	2 J	NS
007G14LF[i]	BEHP	4.8	DNE	NS	NS	NS	8 J	NS
007G15LF[i]	1,1-Dichloroethane	810	DNE	NS	NS	NS	10 U	2 J
	1,1-Dichloroethene	0.044	7	NS	NS	NS	10 U	6 J
	Carbon tetrachloride	0.16	5	NS	NS	NS	20	26
	Chloroform	0.15	100	NS	NS	NS	5 J	10
	TPH - DRO	100	DNE	NS	NS	NS	110	NS
	Trichloroethene	1.6	5	NS	NS	NS	10 U	13
	BEHP	4.8	DNE	NS	NS	NS	14	NS
007G15UF[i]	1,1-Dichloroethane	810	DNE	NS	NS	NS	48 J	43 J
	1,1-Dichloroethene	0.044	7	NS	NS	NS	280	290
	1,2-Dichloroethene (total)	55	70	NS	NS	NS	20 J	22 J
	Benzene	0.36	5	NS	NS	NS	7 J	6 J
	Carbon tetrachloride	0.16	5	NS	NS	NS	20 J	19 J
	Chloroform	0.15	100	NS	NS	NS	70	63
	TPH - DRO	100	DNE	NS	NS	NS	160	NS
	Trichloroethene	1.6	5	NS	NS	NS	840	800
	BEHP	4.8	DNE	NS	NS	NS	1 J	NS
007G16LF[i]	Carbon tetrachloride	0.16	5	NS	NS	NS	27	30
	Chloroform	0.15	100	NS	NS	NS	8 J	5 J
	Trichloroethene	1.6	5	NS	NS	NS	7 J	10
	BEHP	4.8	DNE	NS	NS	NS	1 J	NS
007G17LF[i]	Acetone	3,700	DNE	NS	NS	NS	7 J	10 U

Table E-3
SWMU 7/Apron Area
Organics Detected in Groundwater by Well (μg/L)

Well ID	Constituent	RBC[a]	MCL[b]	Initial[c]	Intermediate[d]	Event 1[e]	Event 2[f]	Event 3[g]
007G18LF[i]	4-Methyl-2-Pentanone (MIBK)	2,900	DNE	NS	NS	NS	10 U	1 J
	Carbon tetrachloride	0.16	5	NS	NS	NS	1 J	1 J
	Chloroform	0.15	100	NS	NS	NS	2 J	2 J
	Tetrachloroethene	1.1	5	NS	NS	NS	1 J	10 U
	Trichloroethene	1.6	5	NS	NS	NS	8 J	6 J
	BEHP	4.8	DNE	NS	NS	NS	1 J	NS

Notes:

a	—	Tap water RBC from the 1997 Risk-Based Concentration Table (December 22, USEPA Region III RBC Memo).
b	—	MCL from USEPA National Primary Drinking Water Standards (October 1996, USEPA Office of Water, Drinking Water Regulations and Health Advisories).
c	—	Initial sampling event in March 1995, following monitoring well installation. All samples were submitted for FSA. Section 2 describes the parameters analyzed in FSA.
d	—	Intermediate sampling event in May 1995, for SWMU 7 to confirm VOC contamination. Samples were submitted for VOC analysis only.
e	—	First of three scheduled long-term monitoring events for Assembly A monitoring wells conducted in November/December 1995. Samples collected from loess wells were submitted for FSA. Samples from fluvial deposits and Cockfield Formation wells were submitted for VOC analysis only. (Wells 007G01LS, 007G03LS, 007G04UC, 007G07LF, 007G08LS, and 007G09UF were not sampled due to field oversight.)
f	—	Second of three scheduled long-term monitoring events for Assembly A monitoring wells conducted in April 1996. Only fluvial deposits wells were sampled; samples were submitted for VOC analysis only. Ten newly installed (3/96) fluvial deposits wells were also sampled; samples were analyzed for FSA. (Well 0GMG09MF was not sampled during this event due to sampling equipment malfunction.)
g	—	Third of three scheduled long-term monitoring events for Assembly A monitoring wells conducted in August 1996. Only fluvial deposits and Cockfield wells were sampled.
h	—	Existing well installed by Geraghty-Miller during a CS/VP in 1985.
i	—	Monitoring well was installed in March 1996 and was initially sampled during the second scheduled monitoring event for Assembly A wells in April 1996. Samples were submitted for FSA.
DNE	—	Does not exist.
NS	—	Sample not submitted for analysis of this constituent this sampling event.
U	—	Constituent analyzed but not detected.
J	—	Compound was detected below the method reporting limit; value estimated.
D	—	Value obtained during a secondary dilution.
UJ	—	Undetected and estimated. The parameter was analyzed but not detected above the listed estimated quantitation limit; the quantitation limit is estimated because one or more laboratory quality control parameters were outside control limits.
LS	—	"LS" indicates well is screened in loess.
MF	—	"MF" indicates well is screened in middle portion of fluvial deposits.
LF	—	"LF" indicates well is screened in lower portion of fluvial deposits.
UF	—	"UF" indicates well is screened in upper portion of fluvial deposits.
UC	—	"UC" indicates well is screened in the upper portion of the Cockfield Formation.

Monitoring well 007G08LS was sampled during the Initial Event and the Intermediate Event, and newly installed well 007G12LF was sampled during Event 2 and Event 3; however, no organic compounds were detected.

Table E-4
SWMU 7/Apron Area
Inorganics Detected in Groundwater by Well (μg/L)

Well ID	Constituent	RBC[a]	MCL[b]	RC[c]	Initial[d]	Event 1[e]	Event 2[f]
007G01LF	Barium	2,600	2,000	232	76.6 J	NS	NS
	Cobalt	2,200	DNE	16.2	10.6 J	NS	NS
	Mercury	11	2	0.25	0.21 J	NS	NS
007G01LS	Barium	2,600	2,000	442	90.4 J	NS	NS
	Chromium	180	100	239	10.4	NS	NS
	Cobalt	2,200	DNE	17.8	5.5 J	NS	NS
	Copper	1,500	1,300	38.8	7.4 J	NS	NS
	Lead	DNE	15	17.5	6.5	NS	NS
	Vanadium	260	DNE	40.9	11.7 J	NS	NS
	Zinc	11,000	DNE	154.6	28.9	NS	NS
007G01UC	Barium	2,600	2,000	287.8	230	NS	NS
	Zinc	11,000	DNE	ND	24.9	NS	NS
007G01UF	Barium	2,600	2,000	232	54.4 J	NS	NS
	Lead	DNE	15	6.6	3.9	NS	NS
	Nickel	730	100	33.4	19.7 J	NS	NS
	Vanadium	260	DNE	17.4	7.1 J	NS	NS
	Zinc	11,000	DNE	39.8	56	NS	NS
007G02UC	Barium	2,600	2,000	287.8	117 J	NS	NS
007G03LF	Barium	2,600	2,000	232	86.1 J	NS	NS
	Cobalt	2,200	DNE	16.2	6.5 J	NS	NS
007G03LS	Arsenic	0.045	50	7.32	2.9 J	NS	NS
	Barium	2,600	2,000	442	229 J	NS	NS
	Chromium	180	100	239	11.8	NS	NS
	Cobalt	2,200	DNE	17.8	8.1 J	NS	NS
	Copper	1,500	1,300	38.8	19.9 J	NS	NS
	Lead	DNE	15	17.5	8.8	NS	NS
	Vanadium	260	DNE	40.9	24.1 J	NS	NS
	Zinc	11,000	DNE	154.6	77	NS	NS
007G03UC	Barium	2,600	2,000	287.8	69 J	NS	NS
	Lead	DNE	15	3.1	2.1 J	NS	NS
007G04LF	Barium	2,600	2,000	232	130 J	NS	NS
	Chromium	180	100	39.8	13.1	NS	NS
	Cobalt	2,200	DNE	16.2	5.8 J	NS	NS
	Copper	1,500	1,300	5.6	17.4 J	NS	NS
	Lead	DNE	15	6.6	7.6	NS	NS
	Zinc	11,000	DNE	39.8	367	NS	NS
007G04UC	Barium	2,600	2,000	287.8	89.6 J	NS	NS
	Cadmium	18	5	ND	4.6 J	NS	NS
	Chromium	180	100	36.6	73.8	NS	NS
	Cobalt	2,200	DNE	14.5	5.3 J	NS	NS
	Copper	1,500	1,300	ND	8.6 J	NS	NS
	Lead	DNE	15	3.1	6.8	NS	NS
	Mercury	11	2	ND	0.26	NS	NS
	Nickel	730	100	41.6	59.3	NS	NS
	Vanadium	260	DNE	11.7	7.7 J	NS	NS

Table E-4
SWMU 7/Apron Area
Inorganics Detected in Groundwater by Well (μg/L)

Well ID	Constituent	RBC[a]	MCL[b]	RC[c]	Initial[d]	Event 1[e]	Event 2[f]
007G04UF	Barium	2,600	2,000	232	20.7 J	NS	NS
	Chromium	180	100	39.8	6 J	NS	NS
	Lead	DNE	15	6.6	2 J	NS	NS
007G05LF	Barium	2,600	2,000	232	76.7 J	NS	NS
	Mercury	11	2	0.25	0.2 J	NS	NS
007G05LS	Barium	2,600	2,000	442	160 J	98.3 J	NS
	Cadmium	18	5	5.88	3 J	3 U	NS
	Chromium	180	100	239	23.1	5 U	NS
	Cobalt	2,200	DNE	17.8	7.2 J	4 U	NS
	Copper	1,500	1,300	38.8	20.8 J	9.1 J	NS
	Lead	DNE	15	17.5	8.6	2.1 J	NS
	Nickel	730	100	173.5	18 J	20 U	NS
	Vanadium	260	DNE	40.9	15.2 J	4 U	NS
	Zinc	11,000	DNE	154.6	46	10 U	NS
007G05UC	Barium	2,600	2,000	287.8	74.8 J	NS	NS
	Mercury	11	2	ND	0.27	NS	NS
007G05UF	Barium	2,600	2,000	232	120 J	NS	NS
	Chromium	180	100	39.8	79.8	NS	NS
	Cobalt	2,200	DNE	16.2	5.5 J	NS	NS
	Copper	1,500	1,300	5.6	15.1 J	NS	NS
	Lead	DNE	15	6.6	10.2	NS	NS
	Mercury	11	2	0.25	0.35 J	NS	NS
	Nickel	730	100	33.4	59.3	NS	NS
	Vanadium	260	DNE	17.4	44.8 J	NS	NS
	Zinc	11,000	DNE	39.8	28.4	NS	NS
007G06LF	Barium	2,600	2,000	232	122 J	NS	NS
	Cobalt	2,200	DNE	16.2	6.6 J	NS	NS
	Lead	DNE	15	6.6	2 J	NS	NS
007G06LS	Arsenic	0.045	50	7.32	5.2 J	2.2 J	NS
	Barium	2,600	2,000	442	251	129 J	NS
	Beryllium	0.016	4	1.3	1 J	1 U	NS
	Cadmium	18	5	5.88	4.3 J	3 U	NS
	Chromium	180	100	239	112	48.4	NS
	Cobalt	2,200	DNE	17.8	19.4 J	5.5 J	NS
	Copper	1,500	1,300	38.8	39.2	16.2 J	NS
	Lead	DNE	15	17.5	21	6 U	NS
	Nickel	730	100	173.5	95.7	30.8 J	NS
	Tin	22,000	DNE	ND	15 U	23.7 J	NS
	Vanadium	260	DNE	40.9	38.6 J	13.7 J	NS
	Zinc	11,000	DNE	154.6	107	38.6 U	NS
007G06UC	Barium	2,600	2,000	287.8	286	NS	NS
	Chromium	180	100	36.6	5.5 J	NS	NS
	Copper	1,500	1,300	ND	6.7 J	NS	NS
	Lead	DNE	15	3.1	2.2 J	NS	NS

Table E-4
SWMU 7/Apron Area
Inorganics Detected in Groundwater by Well (µg/L)

Well ID	Constituent	RBC[a]	MCL[b]	RC[c]	Initial[d]	Event 1[e]	Event 2[f]
007G06UF	Barium	2,600	2,000	232	43.8 J	NS	NS
	Chromium	180	100	39.8	5 J	NS	NS
	Cobalt	2,200	DNE	16.2	5.9 J	NS	NS
	Mercury	11	2	0.25	0.22	NS	NS
007G07LF	Barium	2,600	2,000	232	160 J	NS	NS
	Chromium	180	100	39.8	6.9 J	NS	NS
	Cobalt	2,200	DNE	16.2	18.4 J	NS	NS
	Copper	1,500	1,300	5.6	5.3 J	NS	NS
	Mercury	11	2	0.25	0.28	NS	NS
007G07LS	Arsenic	0.045	50	7.32	4.4 J	2 U	NS
	Barium	2,600	2,000	442	212	125 J	NS
	Chromium	180	100	239	153	54	NS
	Cobalt	2,200	DNE	17.8	13.3 J	4.1 J	NS
	Copper	1,500	1,300	38.8	26.8	13.5 J	NS
	Lead	DNE	15	17.5	16.4	4.8 U	NS
	Mercury	11	2	0.24	0.23	0.2 U	NS
	Nickel	730	100	173.5	124	40 J	NS
	Tin	22,000	DNE	ND	15 U	25.6 J	NS
	Vanadium	260	DNE	40.9	26.6 J	11 J	NS
	Zinc	11,000	DNE	154.6	64	32.7 U	NS
007G07UC	Barium	2,600	2,000	287.8	294	NS	NS
007G07UF	Barium	2,600	2,000	232	76.3 J	NS	NS
	Chromium	180	100	39.8	6.4 J	NS	NS
	Lead	DNE	15	6.6	2.4 J	NS	NS
	Mercury	11	2	0.25	0.2	NS	NS
007G08LF	Barium	2,600	2,000	232	80.5 J	NS	NS
	Cobalt	2,200	DNE	16.2	6.1 J	NS	NS
	Copper	1,500	1,300	5.6	5 J	NS	NS
	Zinc	11,000	DNE	39.8	65	NS	NS
007G08LS	Barium	2,600	2,000	442	53.8 J	NS	NS
	Selenium	180	50	3.45	4.7 J	NS	NS
007G08UC	Barium	2,600	2,000	287.8	369	NS	NS
	Copper	1,500	1,300	ND	8.8 J	NS	NS
	Lead	DNE	15	3.1	3.2 J	NS	NS
007G08UF	Barium	2,600	2,000	232	50.1 J	NS	NS
007G09LF	Barium	2,600	2,000	232	105 J	NS	NS
	Cobalt	2,200	DNE	16.2	6.6 J	NS	NS
007G09LS	Barium	2,600	2,000	442	48.1 J	44.1 J	NS
	Chromium	180	100	239	123	14.7	NS
	Cobalt	2,200	DNE	17.8	7 J	4 U	NS
	Copper	1,500	1,300	38.8	7.9 J	5 U	NS
	Lead	DNE	15	17.5	3.2 J	2.6 J	NS
	Nickel	730	100	173.5	93.5	20 U	NS
	Vanadium	260	DNE	40.9	5.1 J	4 U	NS
	Zinc	11,000	DNE	154.6	117	10.7 J	NS

Table E-4
SWMU 7/Apron Area
Inorganics Detected in Groundwater by Well (μg/L)

Well ID	Constituent	RBC[a]	MCL[b]	RC[c]	Initial[d]	Event 1[e]	Event 2[f]
007G09UC	Arsenic	0.045	50	ND	2.4 J	NS	NS
	Barium	2,600	2,000	287.8	127 J	NS	NS
	Lead	DNE	15	3.1	4	NS	NS
	Mercury	11	2	ND	0.22 J	NS	NS
	Nickel	730	100	41.6	18.6 J	NS	NS
	Silver	180	DNE	ND	54.5 J	NS	NS
	Zinc	11,000	DNE	ND	8.6 J	NS	NS
007G09UF	Barium	2,600	2,000	232	46.5 J	NS	NS
	Cobalt	2,200	DNE	16.2	7.7 J	NS	NS
	Copper	1,500	1,300	5.6	5 J	NS	NS
0GMG09MF[g]	Barium	2,600	2,000	232	39.8 J	NS	NS
	Lead	DNE	15	6.6	2.3 J	NS	NS
007G10LF[h]	Barium	2,600	2,000	232	NS	NS	238
	Chromium	180	100	39.8	NS	NS	9.4 J
	Cobalt	2,200	DNE	16.2	NS	NS	10.3 J
	Lead	DNE	15	6.6	NS	NS	2.7 J
	Zinc	11,000	DNE	39.8	NS	NS	14.8 J
007G11LF[h]	Barium	2,600	2,000	232	NS	NS	204
	Chromium	180	100	39.8	NS	NS	10.1
007G12LF[h]	Barium	2,600	2,000	232	NS	NS	40.2 J
	Chromium	180	100	39.8	NS	NS	92.5 J
	Cobalt	2,200	DNE	16.2	NS	NS	6.2 J
	Lead	DNE	15	6.6	NS	NS	3.5 J
	Nickel	730	100	33.4	NS	NS	55.4 J
	Vanadium	260	DNE	17.4	NS	NS	5.3 J
	Zinc	11,000	DNE	39.8	NS	NS	10.2 J
007G13LF[h]	Arsenic	0.045	50	3.5	NS	NS	10.5
	Barium	2,600	2,000	232	NS	NS	103 J
	Chromium	180	100	39.8	NS	NS	22.2
	Lead	DNE	15	6.6	NS	NS	3 J
	Vanadium	260	DNE	17.4	NS	NS	11.3 J
007G14LF[h]	Barium	2,600	2,000	232	NS	NS	75.4 J
	Chromium	180	100	39.8	NS	NS	13.3
	Cobalt	2,200	DNE	16.2	NS	NS	5.8 J
	Lead	DNE	15	6.6	NS	NS	3.1
	Vanadium	260	DNE	17.4	NS	NS	18.2 J
	Zinc	11,000	DNE	39.8	NS	NS	47.9
007G15LF[h]	Arsenic	0.045	50	3.5	NS	NS	7.9 J
	Barium	2,600	2,000	232	NS	NS	171 J
	Chromium	180	100	39.8	NS	NS	59.6
	Cobalt	2,200	DNE	16.2	NS	NS	16.2 J
	Lead	DNE	15	6.6	NS	NS	29.2
	Mercury	11	2	0.25	NS	NS	0.32
	Nickel	730	100	33.4	NS	NS	33.7 J
	Tin	22,000	DNE	ND	NS	NS	59 J
	Vanadium	260	DNE	17.4	NS	NS	52.6
	Zinc	11,000	DNE	39.8	NS	NS	237

Table E-4
SWMU 7/Apron Area
Inorganics Detected in Groundwater by Well (μg/L)

Well ID	Constituent	RBC[a]	MCL[b]	RC[c]	Initial[d]	Event 1[e]	Event 2[f]
007G15UF[h]	Barium	2,600	2,000	232	NS	NS	124 J
	Cobalt	2,200	DNE	16.2	NS	NS	14.4 J
007G16LF[h]	Barium	2,600	2,000	232	NS	NS	82.1 J
	Cadmium	18	5	3.9	NS	NS	3.8 J
	Cobalt	2,200	DNE	16.2	NS	NS	10.9 J
007G17LF[h]	Barium	2,600	2,000	232	NS	NS	172 J
	Chromium	180	100	39.8	NS	NS	47.3
	Cobalt	2,200	DNE	16.2	NS	NS	20.4 J
	Lead	DNE	15	6.6	NS	NS	7.5
	Nickel	730	100	33.4	NS	NS	27.4 J
	Vanadium	260	DNE	17.4	NS	NS	15 J
	Zinc	11,000	DNE	39.8	NS	NS	278
007G18LF[h]	Barium	2,600	2,000	232	NS	NS	99.7 J
	Chromium	180	100	39.8	NS	NS	8.6 J

Notes:

a — Tap water RBC from the Risk-Based Concentration Table (December 22, 1997, USEPA Region III RBC Memo).
b — MCL from USEPA National Primary Drinking Water Standards (October 1996, USEPA Office of Water, Drinking Water Regulations and Health Advisories).
c — Background RC. The RC is 2X the mean concentration of a constituent detected in samples collected from background monitoring wells that are screened in loess, fluvial deposits, and Cockfield formation. "ND" indicates the constituent was not detected in background wells.
d — Initial sampling event in March 1995, following monitoring well installation. All samples were submitted to the laboratory for FSA. Section 2 describes the parameters analyzed in FSA. (Monitoring well 007G03UF was not analyzed for metals.)
e — First of three scheduled long-term monitoring events for Assembly A monitoring wells conducted in November/December 1995. Samples collected from loess wells were submitted for FSA. Samples from fluvial deposits and Cockfield Formation wells were submitted for VOC analysis only. (Wells 007G01LS, 007G03LS, 007G04UC, 007G07LF, 007G08LS, and 007G09UF were not sampled due to field oversight.)
f — Second of three scheduled long-term monitoring events for Assembly A monitoring wells conducted in April 1996. Samples from ten newly installed (3/96) fluvial deposits wells were submitted for FSA; existing fluvial deposits wells were sampled and submitted for VOC analysis only. (Well 0GMG09MF was not sampled during this event due to sampling equipment malfunction.)
g — Well installed by Geraghty-Miller during a CS/VP in 1985.
h — Monitoring well was installed in March 1996 and was initially sampled during the second scheduled monitoring event for Assembly A wells in April 1996. Samples were submitted for FSA.
NS — Sample not submitted for analysis of this constituent this sampling event.
DNE — Does not exist.
U — Constituent analyzed but not detected.
J — Compound was detected below the method reporting limit; value estimated.
UJ — Undetected and estimated. The parameter was analyzed but not detected above the listed estimated quantitation limit; the quantitation limit is estimated because one or more laboratory quality control parameters were outside control limits.
LS — "LS" indicates well is screened in loess.
MF — "MF" indicates well is screened in middle portion of fluvial deposits.
LF — "LF" indicates well is screened in lower portion of fluvial deposits.
UF — "UF" indicates well is screened in upper portion of fluvial deposits.
UC — "UC" indicates well is screened in the upper portion of the Cockfield Formation.

Appendix F

Fate and Transport of AOC A Contaminants

F.0 FATE AND TRANSPORT OF AOC A CONTAMINANTS

This section provides guidance for evaluating the transport, transformation, and fate of contaminants that have been identified in the Area of Concern (AOC) A — Northside Fluvial Deposits Groundwater at NSA Mid-South. Specifically, fate and transport assessment seeks to evaluate a constituent's ability to become mobile or change in the environment. To accomplish this, the chemical and physical properties that govern the interaction of a contaminant within environmental media must be understood. Characteristics of the site, e.g., topography, geology, and hydrogeology, and characteristics of site soil, sediment, and water, as well as the contaminant's chemical and physical properties, play roles in evaluating the processes of fate and transport. To streamline the fate and transport discussion, this section focuses on providing an understanding of the properties affecting fate and transport. Following this section, those properties will be applied to environmental media and contaminants at the SWMU 7/Apron Area.

Evaluation of the SWMU 7/Apron Area with regard to the above characteristics has identified three potential routes of contaminant migration:

- Air emissions resulting from VOCs released from surface soil.
- Contaminants leaching from soil to groundwater.
- Contaminants migrating by groundwater flow.

No sediment samples were taken during the RFI; therefore, the soil-to-sediment migration pathway is not discussed. Also, the absence of significant bodies of water greatly reduces the potential for migration of constituents from groundwater to surface water bodies.

F.1 Properties Affecting Fate and Transport

The persistence, transport, and fate of chemicals in the environment depend on individual chemical and physical properties, as well as properties of the media in which the chemicals reside. These properties are briefly discussed in the following paragraphs, along with a description of the significance of each property to volatilization, sorption, diffusion, dispersion, biodegradation, and other attenuation processes.

F.1.1 Chemical and Physical Properties

Chemical and physical properties relevant to evaluation of transport and fate of organic contaminants are water solubility, vapor pressure, Henry's law constant, specific gravity, organic carbon partition coefficient, distribution coefficient, and half life. Water solubility and adsorption coefficients are properties of interest for inorganic contaminants. After the properties are introduced, impact on each of the relevant classes of compounds is discussed. Table F-1 provides an overview of chemical property behavior based on these properties.

Water Solubility

The solubility of a chemical in water is the maximum amount of the chemical that will dissolve in pure water at a specified temperature. Chemicals with high solubility are relatively mobile in water and are likely to leach from wastes and soils. These chemicals tend to have low volatilization potential, but do tend to be biodegradable. Conversely, chemicals with low solubility tend to adsorb onto soils and sediments and are not readily biodegraded. They also have a greater tendency to volatilize.

Vapor Pressure

Vapor pressure is a measure of the tendency of a substance to pass from a solid or a liquid to a vapor state. It is measured as the pressure of the gas in equilibrium with the liquid or solid at a given temperature. From dry soils, the vapor pressure determines the volatilization of a given chemical to the atmosphere. From surface waters and moist soils, volatilization depends on vapor pressure and the Henry's law constant (discussed below). A chemical with a vapor pressure less than 10^{-6} millimeters of mercury (mm Hg) tends to associate with particulate matter;

a chemical with a higher vapor pressure tends to associate with the vapor phase. Highly water- soluble compounds generally show little volatilization from water or moist soils unless they also have a high vapor pressure.

Table F-1
Chemical and Physical Properties

Chemical Property	Critical Value[a]	A chemical with a higher value may . . .	A chemical with a lower value may . . .
Vapor Pressure	10^{-3} mm Hg	be more volatile.	be less volatile.
Density[b]	water: 1.0 g/cm^3 air: 1.20 kg/m^3	sink in water or fall in the atmosphere.	float on water or rise in the atmosphere.
Solubility	0 to 100 mg/L	leach from soil, be more mobile in water; and not readily volatilize from water.	adsorb to soil, be immobile in water; and volatilize from water.
Henry's Law Constant	10^{-3} to 10^{-5} atm-m^3/mole	volatilize easily from water.	not volatilize easily from water.
Half-Life	biologically dependent	not degrade readily.	degrade readily.
Organic Carbon Partition Coefficient	10 to 10,000 kg_{oc}/L_{water}	be more apt to remain in soil.	be more mobile and diffuse easily in water.

Notes:
a — Critical values are based on literature review and professional judgement.
b — Approximate density of air at standard temperature and pressure (STP).

Henry's Law Constant

The Henry's law constant describes a linear relation between vapor pressure and water solubility, providing a measure of a chemical's ability to move from water or moist soils to air. Compounds with Henry's law constants greater than 10^{-3} atmospheres-cubic meter per mole (atm-m^3/mole) can be expected to readily volatilize from water. Compounds with values ranging from 10^{-3} to 10^{-5} atm-m^3/mole exhibit moderate volatilization. Compounds with values less than 10^{-5} atm-m^3/mole show limited ability to volatilize from water or moist soils.

Specific Gravity

The specific gravity (SG) of a substance is the ratio of the weight of a given volume of that substance to the weight of the same volume of water. The water weight is usually measured at 4°C; the other substance is often measured at some other temperature, typically 20°C. If the SG of a substance is less than 1.0, that substance will float on water; if the SG is greater than 1.0, the substance will sink in water. The SG can sometimes be used to predict the vertical distribution of the immiscible or insoluble portion of a chemical within an aquifer or other body of water.

Organic Carbon Partition Coefficient

The organic carbon partition coefficient (K_{oc}) is a measure of the degree to which an organic substance will preferentially dissolve in water or in an organic solvent. Chemicals moving through the subsurface will alternately adsorb or desorb from available organic matter in the soil matrix. The higher the K_{oc} values, the greater the tendency of a chemical to be attracted to the organic fraction (f_{oc}) of the soil and lower its mobility in the subsurface environment.

Distribution Coefficient

The distribution coefficient (K_d), a valid representation of the partitioning between liquid and solids, or the ratio of the mass of contaminant in soil to the mass of contaminant dissolved in the groundwater, is used to model contaminant movement through the subsurface. The larger the K_d value, the greater the sorption to the solid phase. The simplest method for acquiring a K_d value for a specific contaminant is to obtain it from a K_{oc} value listed in literature sources. K_{oc} is analogous to K_d, except that the adsorbing material is considered to be the organic carbon (oc) in the soil as opposed to the entire soil matrix. By normalizing K_d on the basis of the organic carbon content of a particular soil, a great deal of the variation observed among K_d values over different soils can be eliminated. Thus, K_d can be estimated from the K_{oc} of the chemical and the f_{oc} in the soil, e.g., $K_d = K_{oc}\ x\ f_{oc}$.

Half-Life

A half life is the time required for the concentration of a substance to decrease from its initial level to one-half that value. The apparent decrease may be caused by various processes, including biodegradation, reactions with other substances, or mass removal from the media in question.

Contaminant Classes

VOCs can be expected to be mobile in the environment based on their physical and chemical properties. They have the potential to volatilize to the atmosphere, leach to groundwater or adsorb to sediment and be transported by erosional processes to surface water, and to flow with groundwater. Relative to other categories of compounds, VOCs have low molecular weight and high water solubility, vapor pressure, and Henry's law constant, along with a corresponding low K_{oc}. These properties all enhance the potential for degradability of VOCs. Relative to chemicals in other categories, many VOCs tend to have relatively short half-lives in groundwater and surface water. VOCs have a limited tendency to adsorb to solids and can be expected to be moderately to highly mobile in the environment. VOCs can migrate via diffusion through soil-air pore spaces to the ground surface, where they can be transported by wind, especially in near-surface soils.

SVOCs generally have higher molecular weights, and lower solubilities, vapor pressures, and Henry's law constants than VOCs. Because of higher K_{oc}, SVOCs tend to sorb to solids and are relatively immobile in the environment. Transport is more likely to occur in the solid rather than in the dissolved phase. These characteristics lead to a likelihood of greater persistence but lower mobility of SVOCs than VOCs in the environment.

Pesticides/PCBs have moderate molecular weights; generally high densities, high K_{oc} values, and generally low solubilities, vapor pressures, and Henry's law constants. Typical fate and transport characterstics include a tendency to sorb to soil particles. They are hydrophobic (avoid water), immobile in the environment, and tend to degrade relatively slowly. Overall, pesticides/PCBs are anticipated to be immobile and persistent in the environment, not readily diffusing into groundwater.

Herbicides can leach from soil particles to groundwater and tend to be mobile in both soil and groundwater. They tend to degrade relatively slowly. The chemical property with the greatest influence on the fate and transport of herbicides is solubility. Herbicides have low Henry's law constants and vapor pressures, and moderate molecular weights, K_{oc} values, and solubilities. Overall, herbicides are expected to be moderately mobile in groundwater, with some retention in soil.

Inorganic chemicals do not degrade in the environment, but they may change chemical form or speciation. They are generally considered to be indefinitely persistent. Inorganic metals may interact with soil or other solids by ion exchange, adsorption, precipitation, or complexation and can act as catalysts in biodegradation. These processes are affected by pH, composition of leachate or groundwater oxidation-reduction condition, and the type and amount of organic matter, minerals, clay, and hydrous oxides present. In general, the solubility of metals in potable groundwater is low, resulting in limited mobility in the environment. However, groundwater containing elevated levels of chloride, bicarbonate, sulfate, or phosphate can enhance the solubility and mobility of metal compounds by the formation of aqueous complexes.

F.1.2 Media Properties

The properties of environmental media used to evaluate fate and transport are total organic carbon, cation exchange capacity, redox conditions, and pH. The following sections briefly discuss these properties.

Total Organic Carbon

The abiotic process of sorption (accumulation of the contaminant at the surface of a solid) will slow down the contaminant's movement as it accumulates on the subsurface medium. As the organic carbon content of the subsurface material increases, the total capacity of the soil to sorb the contaminant increases. In fate and transport calculations, the organic carbon content of a soil is typically expressed as the fraction of organic carbon, and is abbreviated as f_{oc}.

Cation Exchange Capacity

Cation exchange capacity (CEC) reflects the soil's capacity to adsorb ions by neutralizing an ionic deficiency on its surface. Certain compounds can either gain or lose a proton as a function of pH, and thus go from a neutral form to an ionic form. For organic compounds, this ionization greatly increases the solubility of the chemical in the groundwater. The gain of a proton will result in the formation of a positive ion. In this case, the ionic compound may associate to a greater degree with the CEC of the clay minerals. The overall impact on sorption (mobility) will depend on the relative sorption of the neutral and ionic forms of the compound.

Redox Conditions

Oxidation and reduction (redox) refer to the transfer of electrons and species change of ions or compounds. Redox is the process of oxidation (the loss of electrons) and reduction (the gain of electrons). As an example, consider iron in groundwater. Groundwater, which reaches the surface in a highly reduced state, is exposed to the atmosphere (oxygen), resulting in oxidation of the iron. The oxidation of the iron is a reverse process and causes the iron to go from its soluble form to its insoluble complex.

pH

pH is a logarithmic measure of hydrogen ions in soil or water, indicating the medium's acidity or basicity. Chemicals react significantly different under changing pHs. Low pH conditions tend to mobilize chemicals, especially inorganics, while high pH conditions may lead to the formation of immobile metal hydroxides.

Hydrogeology

The physical properties of soil and aquifers (mineralogical composition, particle size distribution, etc.), dictate how a contaminant is transported in the subsurface. Some of the mechanisms are porosity, hydraulic gradient, hydraulic conductivity, unsaturated flow, and saturated flow.

Porosity: This term is defined as the ratio of openings (voids) to the total volume of a soil or rock, and is usually expressed as a percent. Typically, fine-grained materials tend to be better sorted and, thus, tend to have the largest porosities. Porosity indicates the maximum amount of water that a rock or soil can contain when it is saturated.

Hydraulic Gradient: The direction of the groundwater table's slope, or potentiometric surface, indicates the direction of groundwater movement. All other factors being constant, the rate of groundwater movement depends on the hydraulic gradient. The hydraulic gradient is the change in head per unit distance in a given direction. The hydraulic gradient is important in transport of contaminants because it may give an indication as to the velocity and direction at which a contaminant may migrate in groundwater.

Hydraulic Conductivity: The factors controlling groundwater movement are largely dictated by hydraulic conductivity. The hydraulic conductivity depends on the size and arrangement of pores and on the dynamic characteristics of groundwater such as viscosity and density. Hydraulic conductivity refers to the water-transmitting characteristics of a soil or aquifer, and varies in different types of material. If the hydraulic conductivity is essentially the same in any area of soil, it is said to be homogeneous; otherwise, it is heterogeneous. Hydraulic conductivity tends to be greater in sand and less in material containing clay.

Unsaturated Flow: Most aquifer recharge occurs during the percolation of water across the unsaturated zone. The movement of water in the unsaturated zone is controlled by both gravitational and capillary forces. Capillarity results from two forces: the mutual attraction (cohesion) between water molecules and the molecular attraction (adhesion) between water and different solid materials. As a consequence of these two forces, water is pulled upward into a capillary fringe above the water table. Flow in the unsaturated zone is important because contaminants released at the surface which percolate through the unsaturated zone may remain in the unsaturated zone because of capillarity, or may arrive in the unsaturated zone by a fluctuating water table.

Saturated Flow: In the saturated zone, all interconnected openings are full of water, and the groundwater moves through these openings in the direction controlled by the hydraulic gradient. Movement in this zone may be either laminar or turbulent. In laminar flow, water particles move in an orderly manner along streamlines. In turbulent flow, water particles move in a disordered, highly irregular manner, which results in a complex mixing of the particles. Dispersion is an important transport process of contaminants in the saturated zone. Dispersion is the process by which solutes are mixed with uncontaminated water, diluted, and transported based on the heterogeneity of the aquifer. Also, diffusion is the process by which solutes are transported from a region of high concentration to a region of low concentration. In very fine sediments, diffusive transport may be the dominant process. The diffusion process is independent of groundwater flow. Advective flow is the process by which dissolved substances migrate with flowing groundwater. This is the dominant transport process for contaminant movement in groundwater.

F.2 Fate and Transport Approach for the SWMU 7/Apron Area

The fate and transport discussion for the SWMU 7/Apron Area begins by describing site characteristics that have the potential to promote or inhibit migration of contaminants. As presented earlier, four potential routes of migration may exist. The SWMU 7/Apron Area will be evaluated relative to site conditions that affect these migration pathways.

Evaluation of an individual contaminant's ability to migrate is based on four cross-media transfer mechanisms: soil to groundwater, groundwater to surface water, surface soil to sediment (erosion of surface soil), and surface soil to air. As mentioned earlier, for the SWMU 7/Apron Area, only soil to groundwater and soil to air are discussed, and although not a cross-media transport process, the contaminant migration by groundwater flow is discussed. The chemical and physical properties of the contaminant will be evaluated, where necessary, in support of each transfer mechanism. Table F-2 presents the chemical and physical properties used to evaluate fate and transport for all contaminants detected at the SWMU 7/Apron Area, while Table F-3 presents the locations (soil and/or groundwater) of these contaminants.

The following describes the methods used to evaluate the potential migration of contaminants identified at the SWMU 7/Apron Area.

F.2.1 Soil-to-Groundwater Cross-Media Transport

To evaluate the potential for contaminant soil-to-groundwater migration, a phased screening approach was used to focus on chemicals with the greatest potential for impacting the water-bearing zones. The screening process may be summarized as follows:

- Qualitative — Soil and groundwater analytical data were compared to determine which chemicals were present in both media.

The number and placement of monitoring wells or DPT groundwater samples were considered adequate to detect the presence of groundwater contamination. As a result, the qualitative comparison was used to identify those chemicals with reported concentrations in both media.

Table F-2
Fate and Transport Properties for
Contaminants Detected in Soil and Groundwater
SWMU 7/Apron Area — NSA Mid-South

Parameter	Group	Mw[a] (g/mole)	Density[a] (g/cm^3)	Vapor Pressure[a,b] (mm Hg)	Solubility[a,b] (mg/L)	Henry's Law Constant[b,c] ($atm\text{-}m^3$/mole)	Koc[b,c] (kg/L)	SSL soil to gw[d] (μg/kg)	SSL soil to air[d] (μg/kg)
Acenaphthene	SVOC	154.21	1.02e+00	1.60e-03	3.50e+00	1.70e-04	1.78e+01	29000	120000
Acetone	VOC	58.08	7.90e-01	2.70e+02	1.00e+06	3.97e-05	3.70e-01	800	62000000
Acrylonitrile	VOC	53.06	8.00e-01	1.00e+02	7.90e+04	1.10e-04	7.40e-02	NDA	NDA
Anthracene	SVOC	178.24	1.30e+00	2.00e-04	4.50e-02	6.50e-05	1.86e+04	590000	6800
Aroclor-1260	PCB	370.00	1.60e+00	4.10e-05	8.00e-02	7.10e-03	8.22e+05	NDA	NDA
Benzene	VOC	78.11	8.70e-01	9.50e+01	1.80e+03	5.40e-03	5.00e+01	2	500
Benzo(a)anthracene	SVOC	228.30	1.27e+00	5.00e-09	1.20e-02	2.30e-06	1.38e+06	80	27000
Benzo(a)pyrene	SVOC	252.32	1.40e+00	5.60e-09	3.90e-03	2.40e-06	1.77e+06	400	11000
Benzo(b)fluoranthene	SVOC	252.30	NDA	5.00e-07	1.40e-02	1.20e-05	5.50e+05	200	23000
Benzo(g,h,i)perylene	SVOC	276.34	NDA	1.00e-10	2.60e-04	1.40e-07	7.76e+06	NDA	NDA
Benzo(k)fluoranthene	SVOC	252.30	NDA	9.59e-11	5.50e-04	1.04e-03	4.37e+06	2000	0
Bromomethane	VOC	94.95	1.70e+00	1.60e+03	1.30e+04	2.00e-01	8.32e+01	NDA	2000
2-Butanone (MEK)	VOC	72.11	8.10e-01	7.80e+01	2.70e+05	4.66e-05	1.23e+00	NDA	NDA
Carbazole	SVOC	167.20	1.10e+00	4.00e+02	3.80e-03	NDA	NDA	30	11000
Carbon disulfide	VOC	76.13	1.30e+00	3.00e+02	2.10e+03	1.33e-02	2.95e+02	2000	11000
Carbon Tetrachloride	VOC	153.84	1.59e+00	1.14e+02	8.05e+02	3.04e-02	1.10e+02	3	200
Chloroform	VOC	119.38	1.50e+00	1.60e+02	8.00e+03	3.23e-03	4.60e+01	30	200
Chloromethane	VOC	50.49	9.20e-01	3.80e+03	7.30e+03	8.82e-03	2.51e+01	NDA	63

Table F-2
Fate and Transport Properties for
Contaminants Detected in Soil and Groundwater
SWMU 7/Apron Area — NSA Mid-South

Parameter	Group	Mw[a] (g/mole)	Density[a] (g/cm^3)	Vapor Pressure[a,b] (mm Hg)	Solubility[a,b] (mg/L)	Henry's Law Constant[b,c] (atm-m^3/mole)	Koc[b,c] (kg/L)	SSL soil to gw[d] (μg/kg)	SSL soil to air[d] (μg/kg)
Chrysene	SVOC	228.30	1.27e+00	6.30e-09	1.80e-03	7.26e-20	2.45e+05	8000	3600
2,4-D	HERB	221.04	1.40e+00	1.10e-02	6.80e+02	1.37e-10	1.58e+00	1700	7000000
2,4-DB	HERB	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
4,4'-DDD	PEST	320.05	1.50e+00	1.00e-06	2.00e-02	2.16e-05	4.37e+04	800	37000
4,4'-DDE	PEST	319.03	6.49e-06	6.50e-06	4.00e-02	2.34e-05	2.45e+05	3000	10000
4,4'-DDT	PEST	354.49	1.60e+00	1.90e-07	5.00e-03	4.89e-05	3.87e+05	2000	80000
2,4,5-T	HERB	255.48	1.40e+00	7.50e-07	2.80e+02	8.68e-08	2.04e+02	NDA	NDA
2,4,5-TP (Silvex)	HERB	269.51	NDA	5.20e-06	1.40e+02	1.31e-07	2.57e+03	NDA	NDA
1,1-Dichloroethane	VOC	98.96	1.20e+00	1.80e+02	5.50e+03	5.45e-03	3.40e+01	1000	980000
1,1-Dichloroethene	VOC	96.94	1.20e+00	5.90e+02	2.30e+03	1.80e-02	6.50e+01	3	40
1,2-Dichloroethane	VOC	98.96	1.30e+00	6.40e+01	8.70e+03	9.80e-04	1.41e+01	1	300
cis-1,2-Dichloroethene	VOC	96.94	1.20e+00	2.02e+02	8.00e+02	4.08e-03	NDA	20	NDA
1,2-Dichloropropane	VOC	112.99	1.16e+00	4.20e+01	2.70e+03	2.94e-03	5.10e+01	1	11000
Dibenz(a,h)anthracene	SVOC	278.36	1.28e+00	1.00e-10	5.00e-03	7.33e-09	1.66e+06	80	7200
Dibenzofuran	SVOC	168.20	1.10e+00	NDA	1.00e+01	NDA	1.00e+04	NDA	120000
Dicamba	HERB	221.04	NDA	3.40e-05	6.50e+03	1.30e-09	NDA	NDA	NDA
Dichlorodifluoromethane	VOC	120.91	1.35e+00	4.25e+03	2.80e+02	2.97e+00	5.80e+01	NDA	37000
1,2-Dichloroethene	VOC	98.96	NDA	3.00e+02	3.50e+03	5.00e-03	2.30e-02	NDA	NDA

Table F-2
Fate and Transport Properties for
Contaminants Detected in Soil and Groundwater
SWMU 7/Apron Area — NSA Mid-South

Parameter	Group	Mw[a] (g/mole)	Density[a] (g/cm^3)	Vapor Pressure[a,b] (mm Hg)	Solubility[a,b] (mg/L)	Henry's Law Constant[b,c] (atm-m^3/mole)	Koc[b,c] (kg/L)	SSL soil to gw[d] (μg/kg)	SSL soil to air[d] (μg/kg)
Dieldrin	PEST	380.93	1.80e+00	1.80e-07	2.00e-01	2.00e-05	1.34e+04	0.2	2000
Dimethylphthalate	SVOC	194.19	1.19e+00	2.00e-03	4.00e+03	4.20e-07	4.30e+01	NDA	1600000
Di-n-butylphthalate	SVOC	278.35	1.00e+00	1.00e-05	1.30e+01	6.30e-05	1.38e+03	NDA	100000
Ethylbenzene	VOC	106.16	8.70e-01	7.10e+00	1.50e+02	6.60e-03	1.87e+02	700	260000
bis(2-Ethylhexyl)phthalate (BEHP)	SVOC	340.57	9.90e-01	2.00e-07	3.00e-01	1.10e-05	1.00e+05	180000	210000
Fluoranthene	SVOC	202.26	1.30e+00	5.00e-06	2.40e-01	1.69e-02	4.17e+04	210000	68000
Fluorene	SVOC	166.22	1.20e+00	7.00e-03	1.70e+00	2.10e-04	5.01e+03	28000	89000
Guthion	HERB	317.34	1.44e+00	8.00e-09	3.30e+01	NDA	NDA	NDA	NDA
Heptachlor epoxide	PEST	389.32	NDA	2.60e-06	3.50e-01	3.20e-05	2.09e+04	30	1000
2-Hexanone	VOC	100.16	8.11e-01	2.00e+00	3.50e+04	1.75e-03	1.35e+02	NDA	NDA
Indeno(1,2,3-cd)pyrene	SVOC	276.34	6.20e-02	1.00e-10	6.20e-02	2.96e-20	3.09e+07	700	280000
MCPP	HERB	214.60	1.21e+00	NDA	6.20e+02	NDA	NDA	NDA	NDA
2-Methylnaphthalene	SVOC	142.21	1.00e+00	NDA	2.50e+01	NDA	8.51e+03	NDA	NDA
4-Methyl-2-Pentanone (MIBK)	VOC	100.18	8.00e-01	1.50e+01	1.70e+04	1.49e-05	6.17e+00	NDA	NDA
Methylene chloride	VOC	84.93	1.30e+00	3.50e+02	2.00e+04	2.00e-03	2.30e+01	1	7000
Naphthalene	SVOC	128.18	1.10e+00	5.40e-02	3.00e+01	4.60e-04	7.92e+02	4000	180000
Phenanthrene	SVOC	178.24	1.20e+00	6.80e-04	1.00e+00	3.90e-05	2.29e+04	NDA	NDA

Table F-2
Fate and Transport Properties for
Contaminants Detected in Soil and Groundwater
SWMU 7/Apron Area — NSA Mid-South

Parameter	Group	Mw[a] (g/mole)	Density[a] (g/cm^3)	Vapor Pressure[a,b] (mm Hg)	Solubility[a,b] (mg/L)	Henry's Law Constant[b,c] ($atm\text{-}m^3$/mole)	Koc[b,c] (kg/L)	SSL soil to gw[d] (μg/kg)	SSL soil to air[d] (μg/kg)
Phenol	SVOC	94.11	1.10e+00	2.00e-01	8.20e+04	2.70e-07	2.69e+01	5000	21000000
Pyrene	SVOC	202.26	1.30e+00	2.50e-06	1.40e-01	1.09e-05	6.46e+04	210000	56000
Styrene	VOC	104.15	9.06e-01	5.00e+00	3.00e+02	2.61e-03	7.41e+02	200	1400000
TPH	SVOC	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Toluene	VOC	92.13	8.70e-01	2.20e+01	5.20e+02	6.70e-03	1.29e+02	600	520000
Tetrachloroethene (PCE)	VOC	165.85	1.60e+00	1.40e+01	1.50e+02	1.53e-02	2.64e+02	3	11000
Trichloroethene	VOC	131.40	1.50e+00	5.80e+01	1.10e+03	9.10e-03	8.70e+01	3	3000
Trichlorofluoroethane	VOC	137.37	1.50e+00	6.90e+02	1.10e+03	1.10e-01	1.59e+02	NDA	790000
1,1,1-Trichloroethane	VOC	133.40	1.30e+00	1.00e+02	1.60e+03	1.62e-02	1.28e+02	100	980000
Vinyl Chloride	VOC	62.50	9.10e-01	2.60e+03	1.10e+03	1.22e+00	1.10e+01	0.7	2
Xylene	VOC	106.17	8.80e-01	8.70e+00	2.00e+02	7.10e-03	2.34e+02	29000	320000
Arsenic	INO	74.90	5.70e+00	NDA	insoluble	NDA	NDA	1000	380000
Barium	INO	137.33	3.60e+00	NDA	NDA	NDA	NDA	82000	350000000
Beryllium	INO	9.01	1.85e+00	NDA	insoluble	NDA	NDA	3000	690000
Cadmium	INO	112.40	8.64e+00	NDA	NDA	NDA	NDA	400	920000
Chromium	INO	52.00	7.14e+00	NDA	NDA	NDA	NDA	2000	NDA
Cobalt	INO	58.93	8.92e+00	NDA	NDA	NDA	NDA	NDA	NDA
Copper	INO	63.55	8.94e+00	NDA	insoluble	NDA	NDA	NDA	NDA

Table F-2
Fate and Transport Properties for
Contaminants Detected in Soil and Groundwater
SWMU 7/Apron Area — NSA Mid-South

Parameter	Group	Mw[a] (g/mole)	Density[a] (g/cm^3)	Vapor Pressure[a,b] (mm Hg)	Solubility[a,b] (mg/L)	Henry's Law Constant[b,c] (atm-m^3/mole)	Koc[b,c] (kg/L)	SSL soil to gw[d] (μg/kg)	SSL soil to air[d] (μg/kg)
Lead	INO	207.20	1.13e+01	NDA	insoluble	NDA	NDA	NDA	NDA
Mercury	INO	200.60	1.35e+01	NDA	insoluble	NDA	NDA	3000	7000
Nickel	INO	58.71	8.90e+00	NDA	insoluble	NDA	NDA	7000	6900000
Selenium	INO	78.96	4.46e+00	NDA	NDA	NDA	NDA	300	NDA
Silver	INO	107.90	1.05e+01	NDA	NDA	NDA	NDA	2000	NDA
Tin	INO	118.69	7.31e+00	NDA	NDA	NDA	NDA	NDA	NDA
Vanadium	INO	50.94	6.11e+00	NDA	insoluble	NDA	NDA	300000	NDA
Zinc	INO	65.38	7.14e+00	NDA	NDA	NDA	NDA	620000	NDA

Notes:

a — Merck & Co., *The Merck Index*, Merck & Co., Rahway NJ, 1983.
Lide, *CRC Handbook of Chemistry and Physics*, CRC Press, Boca Raton, 1994.
USEPA, *Treatability Database*, USEPA Risk Reduction Engineering Laboratory, Cincinnati OH, 1992.
Resource Consultants, *Chemtox Release K*, 1985-1995.
b — Howard, *Fate and Exposure Data*, Lewis Publishers, Chelsea MI, 1993.
c — Knox, Sabatini, Canter, *Subsurface Transport and Fate Processes*, Lewis Publishers, Chelsea MI, 1993.
d — Soil-to-groundwater soil screening levels (SSLs) are from the *Soil Screening Guidance: Technical Background Document* (U.S. EPA, May 1996). Soil-to-air soil screening levels are from USEPA, *Risk-Based Concentration Table*, USEPA Region III, 1996.
NDA — No Data Available
VOC — Volatile Organic Compound
SVOC — Semivolatile Organic Compound
PCB — Polychlorinated Biphenyl
PES — Pesticide
HER — Herbicide
INO — Inorganic
TPH — Total Petroleum Hydrocarbons
insoluble — Insoluble in water

Table F-3
Contaminants Detected in Soil and Groundwater
SWMU 7/Apron Area — NSA Mid-South

Parameter	Group	Soil Location	Groundwater Location
Acenaphthene	SVOC	Surface	not detected
Acetone	VOC	Surface, Subsurface	Loess, Fluvial Deposits, Cockfield Formation[a]
Acrylonitrile	VOC	not detected	Fluvial Deposits
Anthracene	SVOC	Surface	not detected
Aroclor-1260	PCB	Surface	not detected
Benzene	VOC	Surface, Subsurface	Loess, Fluvial Deposits, Cockfield Formation[a]
Benzo(a)anthracene	SVOC	Surface	not detected
Benzo(a)pyrene	SVOC	Surface	not detected
Benzo(b)fluoranthene	SVOC	Surface	not detected
Benzo(g,h,i)perylene	SVOC	Surface	not detected
Benzo(k)fluoranthene	SVOC	Surface	not detected
Bromomethane	VOC	Surface, Subsurface	Fluvial Deposits, Cockfield Formation[a]
2-Butanone (MEK)	VOC	Surface, Subsurface	Fluvial Deposits
Carbazole	SVOC	Surface	not detected
Carbon Disulfide	VOC	not detected	Fluvial Deposits, Cockfield Formation[a]
Carbon Tetrachloride	VOC	Subsurface	Fluvial Deposits
Chloroform	VOC	not detected	Loess, Fluvial Deposits, Cockfield Formation[a]
Chloromethane	VOC	Surface, Subsurface	Fluvial Deposits, Cockfield Formation[a]
Chrysene	SVOC	Surface	not detected
2,4-D	HERB	Subsurface	not detected
2,4-DB	HERB	Surface	not detected
4,4'-DDD	PEST	Surface	not detected
4,4'-DDE	PEST	Surface	not detected
4,4'-DDT	PEST	Surface	not detected
2,4,5-T	HERB	Surface	not detected

Table F-3
Contaminants Detected in Soil and Groundwater
SWMU 7/Apron Area — NSA Mid-South

Parameter	Group	Soil Location	Groundwater Location
2,4,5-TP (Silvex)	HERB	Surface, Subsurface	not detected
1,1-Dichloroethane	VOC	Subsurface	Loess, Fluvial Deposits, Cockfield Formation[a]
1,1-Dichloroethene	VOC	not detected	Loess, Fluvial Deposits
1,2-Dichloroethane	VOC	not detected	Loess, Fluvial Deposits, Cockfield Formation[a]
cis-1,2-Dichloroethene	VOC	Subsurface	Fluvial Deposits
1,2-Dichloropropane	VOC	not detected	Loess, Fluvial Deposits
Dibenz(a,h)anthracene	SVOC	Surface	not detected
Dibenzofuran	SVOC	Surface	not detected
Dicamba	HERB	Surface	not detected
Dichlorodifluoromethane	VOC	not detected	Fluvial Deposits
1,2-Dichloroethene	VOC	not detected	Loess, Fluvial Deposits, Cockfield Formation[a]
Dieldrin	PEST	Surface	not detected
Dimethylphthalate	SVOC	not detected	Cockfield Formation[a]
Di-n-butylphthalate	SVOC	not detected	Loess
Ethylbenzene	VOC	Surface, Subsurface	Loess, Fluvial Deposits
BEHP	SVOC	Surface, Subsurface	Loess, Fluvial Deposits
Fluoranthene	SVOC	Surface	not detected
Fluorene	SVOC	Surface	not detected
Guthion	HERB	Surface	not detected
Heptachlor Epoxide	PEST	Surface	not detected
2-Hexanone	VOC	Subsurface	Loess, Fluvial Deposits
Indeno(1,2,3-cd)pyrene	SVOC	Surface	not detected
MCPP	HERB	Subsurface	not detected
2-Methylnaphthalene	SVOC	Surface	not detected

Table F-3
Contaminants Detected in Soil and Groundwater
SWMU 7/Apron Area — NSA Mid-South

Parameter	Group	Soil Location	Groundwater Location
4-Methyl-2-Pentanone (MIBK)	VOC	Subsurface	Fluvial Deposits, Cockfield Formation[a]
Methylene chloride	VOC	Surface	Fluvial Deposits
Naphthalene	SVOC	Surface	Fluvial Deposits
Phenanthrene	SVOC	Surface	not detected
Phenol	SVOC	not detected	Loess, Fluvial Deposits
Pyrene	SVOC	Surface	not detected
Styrene	VOC	not detected	Fluvial Deposits
TPH-DRO	SVOC	Surface, Subsurface	Loess, Fluvial Deposits
Toluene	VOC	Surface, Subsurface	Fluvial Deposits, Cockfield Formation[a]
Tetrachloroethene	VOC	Subsurface	Loess, Fluvial Deposits, Cockfield Formation[a]
Trichloroethene	VOC	Subsurface	Loess, Fluvial Deposits, Cockfield Formation[a]
Trichlorofluoroethane	VOC	not detected	Fluvial Deposits
1,1,1-Trichloroethane	VOC	Subsurface	not detected
Vinyl Chloride	VOC	not detected	Fluvial Deposits
Xylene	VOC	Surface, Subsurface	Fluvial Deposits
Arsenic	INO	Surface, Subsurface	Loess, Fluvial Deposits, Cockfield Formation[a]
Barium	INO	Surface, Subsurface	Loess, Fluvial Deposits, Cockfield Formation[a]
Beryllium	INO	Surface, Subsurface	Loess
Cadmium	INO	Surface, Subsurface	Loess, Fluvial Deposits, Cockfield Formation[a]
Chromium	INO	Surface, Subsurface	Loess, Fluvial Deposits, Cockfield Formation[a]
Cobalt	INO	Surface, Subsurface	Loess, Fluvial Deposits, Cockfield Formation[a]
Copper	INO	Surface, Subsurface	Loess, Fluvial Deposits, Cockfield Formation[a]
Lead	INO	Surface, Subsurface	Loess, Fluvial Deposits, Cockfield Formation[a]
Mercury	INO	Surface, Subsurface	Loess, Fluvial Deposits, Cockfield Formation[a]
Nickel	INO	Surface, Subsurface	Loess, Fluvial Deposits, Cockfield Formation[a]

Table F-3
Contaminants Detected in Soil and Groundwater
SWMU 7/Apron Area — NSA Mid-South

Parameter	Group	Soil Location	Groundwater Location
Selenium	INO	Surface	Loess, Fluvial Deposits
Silver	INO	not detected	Fluvial Deposits, Cockfield Formation[a]
Tin	INO	Surface	Loess, Fluvial Deposits
Vanadium	INO	Surface, Subsurface	Loess, Fluvial Deposits, Cockfield Formation[a]
Zinc	INO	Surface, Subsurface	Loess, Fluvial Deposits, Cockfield Formation[a]

Note:
a — At the time of the initial sampling event, monitoring well 007G08UC contained 1,2-dichloroethane, benzene, chloroform, trichloroethene, and tetrachloroethylene. During the three subsequent sampling events, none of these compounds were detected. Arsenic was the single inorganic detected in the upper Cockfield exceeding both its RBC and its RC.

- Quantitative — Soil results were compared to the leachability-based soil-to-groundwater screening levels as presented in the *Soil Screening Guidance: Technical Background Document* (U.S. EPA, May 1996). If the maximum detected concentration for an organic contaminant exceeds its SSL, that contaminant is considered a threat for impacting a water-bearing zone. If the maximum detected concentration of an inorganic contaminant exceeds its SSL ***and*** its background RC, the contaminant is considered a threat for impacting a water-bearing zone.

Table F-4 compares the maximum detected concentration of soil contaminants for the SWMU 7/Apron Area to the risk-based soil screening level considered protective of groundwater. Additional notations are made for contaminants detected in groundwater.

Table F-4
Comparison of Soil to Groundwater SSL (μg/kg)

Parameter	Maximum Surface Soil Concentration	Maximum Subsurface Soil Concentration	Soil to Groundwater Screening Level	Exceeds SSL? (# locations)	Detected in Groundwater
VOCs					
2-Butanone (MEK)	69	19 (Loess)	No SSL	Not applicable	Fluvial Deposits
2-Hexanone	None detected	15 (Loess)	No SSL	Not applicable	Loess, Fluvial Deposits
4-Methyl-2-Pentanone	None detected	17 (Loess)	No SSL	Not applicable	Fluvial Deposits, Cockfield Formation
Acetone	1,100	220 (Loess) 3 (Fluvial) 16 (Cockfield)	800	***in Surface Soil (1)***	Loess, Fluvial Deposits, Cockfield Formation
Benzene	8	29 (Loess)	22	***in Loess (1)***	Loess, Fluvial Deposits, Cockfield Formation
Bromomethane	6	4 (Loess)	No SSL	Not applicable	Fluvial Deposits, Cockfield Formation
Carbon Tetrachloride	None detected	3 (Fluvial)	3	***in Fluvial Deposits (1)***	Fluvial Deposits
Chloromethane	6	6 (Loess)	No SSL	No	Fluvial Deposits, Cockfield Formation
cis-1,2-Dichloroethene	None detected	2 (Loess)	20	No	Fluvial Deposits
1,1-Dichloroethane	None detected	3 (Loess)	1,000	No	Loess, Fluvial Deposits, Cockfield Formation
Ethylbenzene	14	2 (Loess)	700	No	Loess, Fluvial Deposits
Methylene Chloride	1	None detected	1	No	Fluvial Deposits
Toluene	170	9 (Loess)	600	No	Fluvial Deposits, Cockfield Formation
Trichloroethene	None detected	12 (Loess) 2.6 (Fluvial) 4 (Cockfield)	3	***in Loess (1), and Cockfield (1)***	Loess, Fluvial Deposits, Cockfield Formation
1,1,1-Trichloroethane	None detected	6 (Fluvial) 108 (Cockfield)	100	Not applicable	No
Xylene (Total)	49	5 (Loess)	29,000	No	Fluvial Deposits
Tetrachloroethene	None detected	2 (Fluvial)	3	No	Loess, Fluvial Deposits, Cockfield Formation
SVOCs					
2-Methylnaphthalene	82	None detected	No SSL	Not applicable	No
Acenaphthene	120	None detected	29,000	No	No

Table F-4
Comparison of Soil to Groundwater SSL (μg/kg)

Parameter	Maximum Surface Soil Concentration	Maximum Subsurface Soil Concentration	Soil to Groundwater Screening Level	Exceeds SSL? (# locations)	Detected in Groundwater
Anthracene	310	None detected	590,000	No	No
Benzo(a)anthracene	1,200	None detected	80	*in Surface Soil (6)*	No
Benzo(a)pyrene	1,200	None detected	400	*in Surface Soil (2)*	No
Benzo(b)fluoranthene	1,200	None detected	200	*in Surface Soil (5)*	No
Benzo(g,h,i)perylene	710	None detected	No SSL	Not applicable	No
Benzo(k)fluoranthene	990	None detected	2,000	No	No
BEHP	250	55 (Loess)	180,000	No	Loess, Fluvial Deposits
Carbazole	160	None detected	30	*in Surface Soil (5)*	No
Chrysene	1,200	None detected	8,000	No	No
Dibenz(a,h)anthracene	240	None detected	80	*in Surface Soil (3)*	No
Dibenzofuran	72	None detected	No SSL	Not applicable	No
Fluoranthene	2,800	None detected	210,000	No	No
Fluorene	190	None detected	28,000	No	No
Indeno(1,2,3-cd)pyrene	610	None detected	7,000	No	No
Naphthalene	220	None detected	4,000	No	Fluvial Deposits
Phenanthrene	1,600	None detected	No SSL	Not applicable	No
Pyrene	2,100	None detected	No SSL	Not applicable	No
TPH	3,900	750 (Loess)	No SSL	Not applicable	Loess, Fluvial Deposits
Herbicides					
2,4,5-T	1.7	None detected	No SSL	Not applicable	No
2,4,5-TP (Silvex)	3.8	1.6 (Loess)	No SSL	Not applicable	No
2,4-D	None detected	120 (Loess)	No SSL	Not applicable	No
2,4-DB	59	None detected	No SSL	Not applicable	No
Dicamba	8.6	None detected	No SSL	Not applicable	No
Guthion	280	None detected	No SSL	Not applicable	No

Table F-4
Comparison of Soil to Groundwater SSL (μg/kg)

Parameter	Maximum Surface Soil Concentration	Maximum Subsurface Soil Concentration	Soil to Groundwater Screening Level	Exceeds SSL? (# locations)	Detected in Groundwater
MCPP	NA	3,300 (Loess)	No SSL	Not applicable	No
Pesticides/PCBs					
4,4'-DDD	5.6	None detected	800	No	No
4,4'-DDE	12	None detected	3,000	No	No
4,4'-DDT	38	None detected	2,000	No	No
Dieldrin	420	None detected	0.2	*in Surface Soil (8)*	No
Heptachlor Epoxide	42	None detected	30	*in Surface Soil (1)*	No
Aroclor-1260	20,000	None detected	No SSL	Not applicable	No
Inorganics	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**		
Arsenic	14	11.9 (Loess) 4.7 (Fluvial)	1	No	Loess, Fluvial Deposits, Cockfield Formation
Barium	272	216 (Loess) 78.4 (Fluvial)	82	*in Surface Soil (1)*	Loess, Fluvial Deposits, Cockfield Formation
Beryllium	0.65	0.79 (Loess) 0.61 (Fluvial)	3	No	Loess
Cadmium	4.2	21.4 (Loess) 2.3 (Fluvial)	0.4	*in Surface Soil (10) and Loess (7)*	Loess, Fluvial Deposits, Cockfield Formation
Chromium	24.1	23.9 (Loess) 12.6 (Fluvial)	2	*in Surface Soil (1)*	Loess, Fluvial Deposits, Cockfield Formation
Cobalt	18.6	10.2 (Loess) 5.3 (Fluvial)	No SSL	Not applicable	Loess, Fluvial Deposits, Cockfield Formation
Copper	22.5	20.6 (Loess) 13.3 (Fluvial)	No SSL	Not applicable	Loess, Fluvial Deposits, Cockfield Formation
Lead	132	26.9 (Loess) 7.1 (Fluvial)	No SSL	Not applicable	Loess, Fluvial Deposits, Cockfield Formation
Mercury	0.12	0.15 (Loess)	No SSL	Not applicable	Loess, Fluvial Deposits, Cockfield Formation
Nickel	23.7	28 (Loess) 12.8 (Fluvial)	7	*in Surface Soil (3) , Loess (14), and Fluvial (1)*	Loess, Fluvial Deposits, Cockfield Formation
Selenium	0.55	None detected	0.3	*In Surface Soil (1)*	Loess, Fluvial Deposits
Tin	42.9	None detected	No SSL	Not applicable	Loess, Fluvial Deposits

Table F-4
Comparison of Soil to Groundwater SSL (μg/kg)

Parameter	Maximum Surface Soil Concentration	Maximum Subsurface Soil Concentration	Soil to Groundwater Screening Level	Exceeds SSL? (# locations)	Detected in Groundwater
Vanadium	34.9	34.8 (Loess) 25.4 (Fluvial)	300	No	Loess, Fluvial Deposits, Cockfield Formation
Zinc	154	73.1 (Loess) 28.2 (Fluvial)	620	No	Loess, Fluvial Deposits, Cockfield Formation

Sixteen contaminants pose a potential soil-to-groundwater migration concern as determined by soil concentrations that exceed groundwater protection SSLs. For inorganics, the potential exists if the maximum concentration exceeds the SSL *and* the background RC. The sixteen compounds are four VOCs (acetone, benzene, carbon tetrachloride, and trichloroethene), five SVOCs [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, carbazole, and dibenz(a,h)anthracene], two pesticides (dieldrin and heptachlor epoxide), and five inorganics (barium, selenium, chromium, nickel, and cadmium). Of these contaminants, only acetone, benzene, carbon tetrachloride, trichloroethene, barium, cadmium, and nickel are also present in groundwater. Figure 4-2 depicts the geographical locations of these compounds.

From Table F-4, it can be seen that most contaminants detected in groundwater are VOCs, which generally have a low affinity for soil particles and relatively high water solubilities. SVOCs and pesticides have a high affinity for soil particles and are typically immobile in the soil matrix. Most of the contaminants considered a potential threat to underlying groundwater by exceeding their SSLs, are inorganics, pesticides, and SVOCs. The presence of inorganics in groundwater may be due to sampling technique (i.e., presence of silt or soil particles in samples) or contaminants being carried downward during drilling activities.

Several contaminants have been detected in groundwater, but not in soil; most are VOCs. As discussed in Section 5.1.1, VOCs can be expected to be mobile in the environment based on their physical and chemical properties. They have a limited tendency to adsorb to solids and degrade much easier than other compounds do in the environment. This may explain the limited occurrence of VOCs in soil.

The presence of VOC contaminants within the SWMU 7/Apron Area appears to be traceable to historical facility practices. Most groundwater VOCs were detected in samples of groundwater from the fluvial deposits. The fluvial deposits, which underlie the loess, consist of sand, gravel, and some clay. Typically, a downward vertical gradient exists between water in the loess and the fluvial deposits. The fluvial deposits are underlain by the Cockfield Formation, which is a heterogeneous formation of very fine silty sand, interbedded with clay and silt lenses or clay with interbedded fine sand lenses. The more permeable characteristics of the fluvial deposits, compared to the relatively impermeable properties of the overlying loess and the underlying Cockfield Formation, result in the fluvial deposits being the preferential zone of groundwater flow and the route for contaminant transport.

F.2.2 Soil-to-Air Cross-Media Transport

To evaluate the potential for soil to air migration of contaminants, a screening approach was used to focus on contaminants with the greatest potential to volatilize in sufficient quantities to create a human health threat in ambient air. The screening process may be summarized as follows:

- Quantitative — The maximum concentrations of contaminants detected in surface soil at the SWMU 7/Apron Area were compared to soil-to-air screening levels as presented in the *USEPA Region III RBC Table*, June 1996.

No qualitative screening was performed because ambient air sampling was not part of the RFI at the SWMU 7/Apron Area.

If soil concentrations do not exceed soil-to-air volatilization screening levels, it was assumed that no significant migration potential exists and current surface soil conditions are protective of human health relative to potential inhalation exposure pathways. Other factors include, type of cover (vegetation, concrete, etc.), physical properties of the surface soil that might limit or enhance mobility of contaminants, and physical/chemical properties of the class of contaminants (e.g., VOCs are more likely to volatilize from soil to air than SVOCs).

As can be seen from Table F-5, soil-to-air is not a significant migration pathway at the SWMU 7/Apron Area since no contaminant detected in surface soil exceeded its soil-to-air SSL. Also, most of the area is covered with either asphalt or concrete, eliminating the potential for soil-to-air migration.

Table F-5
Comparison of Soil to Air SSL (μg/kg)

Parameter	Maximum Surface Soil Concentration	Soil to Air Screening Level	Exceeds SSL
VOCs			
2-Butanone (MEK)	69	No SSL	Not applicable
2-Hexanone	None detected	No SSL	Not applicable
4-Methyl-2-Pentanone	None detected	No SSL	Not applicable
Acetone	1,100	62,000,000	No
Benzene	8	500	No
Bromomethane	6	2,000	No
Carbon Tetrachloride	None detected	200	No
Chloromethane	6	63	No
cis-1,2-Dichloroethene	None detected	No SSL	Not applicable
1,1-Dichloroethane	None detected	980,000	Not applicable
Ethylbenzene	14	260,000	No
Methylene Chloride	1	7,000	No
Toluene	170	520,000	No

Table F-5
Comparison of Soil to Air SSL (μg/kg)

Parameter	Maximum Surface Soil Concentration	Soil to Air Screening Level	Exceeds SSL
Trichloroethene	None detected	3,000	Not applicable
1,1-Trichloroethane	None detected	980,000	Not applicable
Xylene (Total)	49	320,000	No
Tetrachloroethene	None detected	11,000	Not applicable
SVOCs			
2-Methylnaphthalene	82	No SSL	Not applicable
Acenaphthene	120	120,000	No
Anthracene	310	6,800	No
Benzo(a)anthracene	1,200	27,000	No
Benzo(a)pyrene	1,200	11,000	No
Benzo(b)fluoranthene	1,200	23,000	No
Benzo(g,h,i)perylene	710	No SSL	Not applicable
Benzo(k)fluoranthene	990	No SSL	Not applicable
BEHP	250	210,000	No
Carbazole	160	11,000	No
Chrysene	1,200	3,600	No
Dibenz(a,h)anthracene	240	7,200	No
Dibenzofuran	72	120,000	No
Fluoranthene	2,800	68,000	No
Fluorene	190	89,000	No
Indeno(1,2,3-cd)pyrene	610	280,000	No
Naphthalene	220	180,000	No
Phenanthrene	1,600	No SSL	Not applicable
Pyrene	2,100	56,000	No
TPH	3,900	No SSL	Not applicable
Herbicides			
2,4,5-T	1.7	No SSL	Not applicable
2,4,5-TP (Silvex)	3.8	No SSL	Not applicable

Table F-5
Comparison of Soil to Air SSL (μg/kg)

Parameter	Maximum Surface Soil Concentration	Soil to Air Screening Level	Exceeds SSL
2,4-D	None detected	7,000,000	Not applicable
2,4-DB	59	No SSL	Not applicable
Dicamba	8.6	No SSL	Not applicable
Guthion	280	No SSL	Not applicable
MCPP	None detected	No SSL	Not applicable
Pesticides/PCBs			
4,4'-DDD	5.6	37,000	No
4,4'-DDE	12	10,000	No
4,4'-DDT	38	80,000	No
Dieldrin	420	2,000	No
Heptachlor Epoxide	42	1,000	No
Aroclor-1260	20,000	No SSL	Not applicable
Inorganics	**(mg/kg)**	**(mg/kg)**	**ExceedsSSL**
Arsenic	14	380	No
Barium	272	350,000	No
Beryllium	0.65	690,000	No
Cadmium	4.2	920,000	No
Chromium	24.1	No SSL	Not applicable
Cobalt	18.6	No SSL	Not applicable
Copper	22.5	No SSL	Not applicable
Lead	132	No SSL	Not applicable
Mercury	0.12	7	No
Nickel	23.7	6,900	No
Selenium	0.55	No SSL	Not applicable
Tin	42.9	No SSL	Not applicable
Vanadium	34.9	No SSL	Not applicable
Zinc	154	No SSL	Not applicable

F.3 Contaminant Migration in Groundwater

The transport of dissolved contaminants in groundwater is controlled by advection, diffusion, and dispersion. Other parameters controlling transport are solubility and sorption. The principal component of migration is advection, the movement of dissolved contaminants with groundwater flow. The remaining two processes, diffusion and dispersion, are both physical and chemical processes affected by site-specific factors including groundwater velocity, formation heterogeneity, and the retardation factor.

Advective transport is the movement of contaminants along with flowing groundwater in porous media. Diffusion is a molecular mass-transport process in which solutes move from areas of higher concentration to areas of lower concentration. The diffusion process is independent of groundwater flow. Dispersion is a mixing process caused by velocity variations in the porous media. Dispersion causes sharp contaminant fronts to spread, diluting the solute at the advancing edge of the front. In most environmental settings, including the SWMU 7/Apron Area, advection is the dominant process that drives contaminant migration in groundwater.

Previous sections have described the SWMU 7/Apron Area hydrogeology and discussed the nature and extent of contaminants detected in groundwater during the investigation. Groundwater is the most complex environmental medium investigated during the RFI and is the transport medium in which most of the SWMU 7/Apron Area contaminants will migrate. As detailed earlier, groundwater contamination includes VOCs, SVOCs, and inorganics. Migration pathways for contaminants in groundwater include advective flow from upgradient groundwater locations in the loess, fluvial deposits, and upper part of the Cockfield Formation. However, as discussed earlier, fluvial deposits is the preferential pathway for contaminant transport in groundwater and the zone where the majority of contaminants were detected.

Table F-6 lists the contaminants that exceeded either their tap water RBC, MCL, or both. Geographical locations and occurrences of contaminants exceeding tap water RBCs and/or MCLs in loess groundwater are shown on Figure 4-4, in fluvial deposits groundwater on Figures 4-6 through 4-15, and in upper Cockfield Formation groundwater on Figure 4-5. With the exception of TPH, lead, and arsenic, all contaminants exceeding either their RBC or MCL in groundwater were VOCs. Again, the absence of other contaminant groups exceeding RBCs and/or MCLs in groundwater may be the result of their lack of mobility in the subsurface, either soil or groundwater. SVOCs, pesticides/PCBs, and inorganics have relatively low solubilities and higher K_{oc} values, rendering them relatively immobile in soil and not readily diffusable into groundwater.

Table F-6
RBC and MCL Exceedances in Groundwater

in Loess Groundwater	in Fluvial Deposits Groundwater	in Upper Cockfield Formation Groundwater*
Benzene — exceeded RBC and MCL	Benzene — exceeded MCL	Arsenic — exceeded RBC
Chloroform — exceeded RBC	Chloroform — exceeded MCL	Benzene — exceeded RBC
1,2-Dichloroethane — exceeded RBC	Carbon Tetrachloride — exceeded MCL	Chloroform — exceeded RBC
1,1-Dichloroethene — exceeded RBC	1,1-Dichloroethane — exceeded MCL	Chloromethane — exceeded RBC
1,2-Dichloropropane — exceeded RBC	1,2-Dichloroethane — exceeded MCL	1,2-Dichloroethane — exceeded RBC
Tetrachloroethene — exceeded RBC	1,1-Dichloroethene — exceeded MCL	Tetrachloroethene — exceeded RBC and MCL
Trichloroethene — exceeded RBC and MCL	1,2-Dichloroethene — exceeded MCL	Trichloroethene — exceeded RBC
TPH — exceeded RBC	Lead — exceeded MCL	
Lead — exceeded RBC	Methylene Chloride — exceeded MCL	
	Tetrachloroethene — exceeded MCL	
	Trichloroethene — exceeded MCL	
	Vinyl Chloride — exceeded MCL	

Note:
* — Initial groundwater sampling event only; contaminants were absent during subsequent three sampling events.

F.3.1 VOCs

The persistence of VOC contaminants in groundwater is primarily governed by the migration of contaminants and to a lesser degree, degradation. Three of the VOCs present in groundwater (trichloroethene, tetrachloroethene, and carbon tetrachloride) are chlorinated solvents with densities greater than water, and six other VOCs (1,1-dichloroethane, cis-1,2-dichloroethene, 1,2-dichloroethane, 1,1-dichloroethene, 1,1-trichloroethane, and vinyl chloride) also present in groundwater are degradation products of trichloroethene. These types of chlorinated solvents exhibit unique chemical, physical, and biological characteristics that influence their ability to migrate within an environmental medium. The influence of the following general characteristics are lessened when a chlorinated solvent is present in the environment as a dissolved phase instead of in a free phase (separate from water).

- Density — The relatively high densities of chlorinated solvents compared to water mean that if a sufficient volume of a chlorinated solvent is released, then liquid solvent under the force of gravity may be able to penetrate the subsurface media and/or groundwater.

- Viscosity — Low viscosities allow rapid downward movement in the subsurface.

- Interfacial Tension — The low interfacial tension between a liquid chlorinated solvent phase and water allows it to enter small fractures and pore spaces, facilitating penetration into the subsurface. Low interfacial tension also contributes to the low retention capacities of soil.

- Solubility — Chlorinated solvents have low absolute solubilities. When such a compound is released to the ground surface, liquid solvent can migrate as a free phase in the subsurface and persist there as a separate phase. Free-phase chlorinated solvents have not been detected at the SWMU 7/Apron Area.

- Partitioning — The low partitioning to soil exhibited by the chlorinated solvents means that soil and rock tend to not bind these contaminants strongly, resulting in limited to no contaminant retention by the soil or aquifer.

- Volatility — The high volatilities of chlorinated solvents result in an often immediate downward penetration. Volatilization depends on vapor pressure; for example, a contaminant with a relatively high vapor pressure tends to associate with the vapor phase. Conversely, a contaminant with a relatively low vapor pressure tends to associate with particulate matter, not readily penetrating through soil. Any volatilization during the migration process often only increases the migratory potential and complexity by creating a vapor-phase plume. Once in the subsurface, the vapor plume can migrate in directions other than that of the liquid mass. Once the chlorinated solvents reach the saturated zone, the high volatility of the compounds have little effect on removing solvent mass because vapor transport across the capillary fringe can be exceedingly slow (McCarthy and Johnson, 1992).

The remaining VOCs detected in groundwater possess densities less than that of water. These VOCs, when released in sufficient volume into the subsurface, tend to migrate through soil with greater retention capacity in soil than that of chlorinated solvents, eventually "pooling" on top of the water table. Both dissolved and free phases move with groundwater flow. No free phase VOCs have been detected at the SWMU 7/Apron Area.

F.3.2 SVOCs

The transport of SVOCs in groundwater depends primarily on the chemical's solubility and the organic content of the soil. Typically, SVOCs are not mobile in the subsurface and the adsorption of SVOCs onto soil particles may be the main transport process for SVOCs in groundwater when soil particles become mobile. The lack of migration can be attributed to high retardation factors for SVOCs due to a high distribution coefficient. Therefore, transport of SVOCs by advection is not a significant process and SVOC concentrations are not expected to extend great distances beyond a source area.

No SVOCs exceeded either their RBC or MCL in groundwater at the SWMU 7/Apron Area, and only six SVOC contaminants were detected in groundwater: dimethylphthalate, di-n-butylphthalate, BEHP, naphthalene, phenol, and TPH-DRO.

Geographical occurrences of SVOCs in groundwater do not indicate a likely migration pathway, with detections noted in only five monitoring wells for all SVOCs, except for BEHP. BEHP was detected in 11 monitoring wells during the investigation, with concentrations in only two monitoring wells exceeding the RBC. Because the source of BEHP is unknown at the SWMU 7/Apron Area, it is assumed that BEHP migration in groundwater would be at the least minimal. Detections of BEHP could be attributable to gloves and equipment, or polyvinyl chloride well casing.

F.3.3 Inorganics

Metals have fairly limited mobility in groundwater because of cation exchange or sorption on the surface of mineral grains. Metals are mobile in groundwater if soluble ions exist and the soil has a low cation-exchange capacity. They can also become mobile if they are attached to a mobile colloid.

The sorption of metals onto mobile sediments may be a transport mechanism for metals in groundwater at the SWMU 7/Apron Area. If the metals detected in SWMU 7/Apron Area groundwater are associated with contaminants at the site, they are likely to become diluted and possibly naturally filter when migrating.

Only lead exceeded both its RC (in loess groundwater) and TTAL (in fluvial deposits groundwater). Arsenic exceeded its RBC and RC in groundwater from the upper part of the Cockfield Formation. Although 13 other inorganics were detected in groundwater, none exceeded their RC and RBC or MCL, and are indicative of naturally occurring concentrations of these constituents.

F.4 Summary

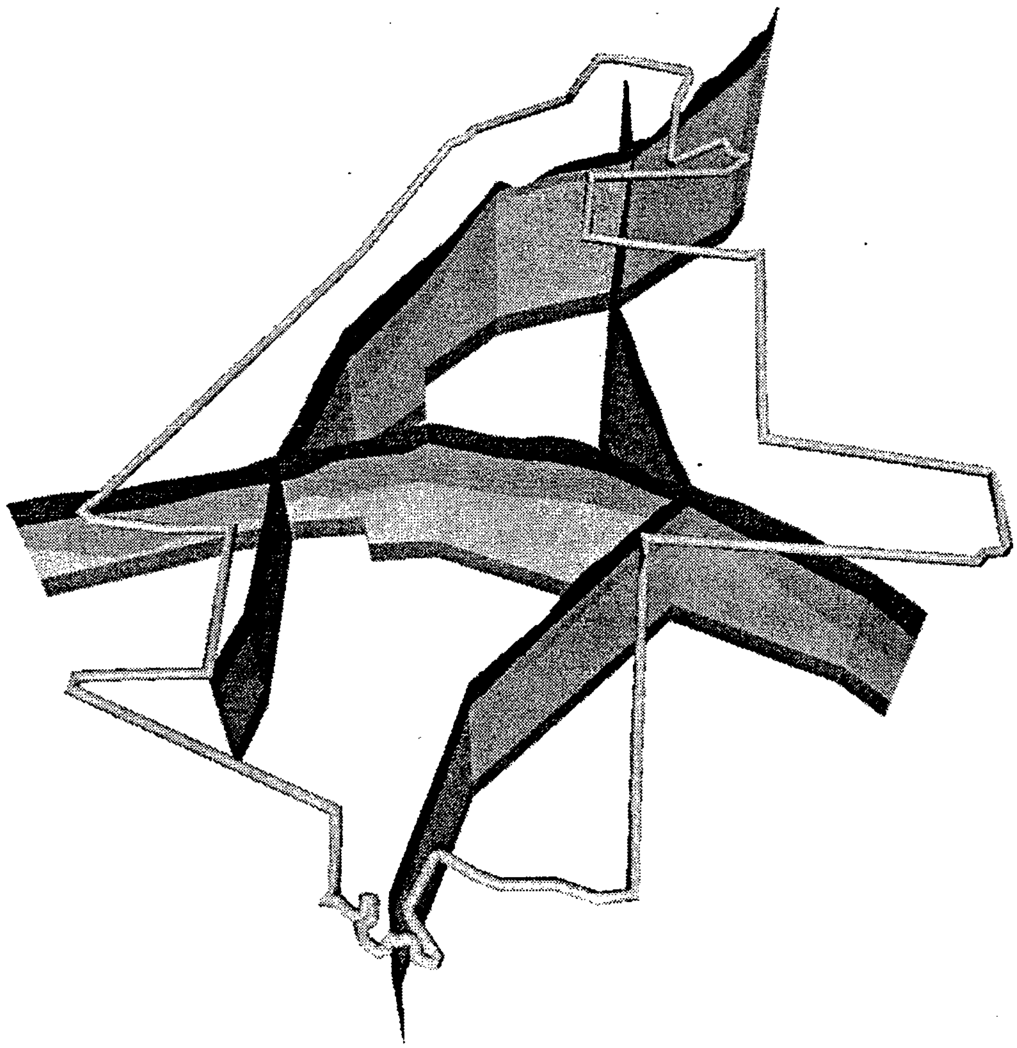
Three groundwater zones were monitored during the SWMU 7/Apron Area RFI: the loess, the fluvial deposits, and the Cockfield Formation. The receptor primarily is groundwater in the fluvial deposits, as several VOCs exceeded their MCLs in this medium. Potential receptors within the fluvial deposits groundwater consist of shallow private domestic wells. However, the nearest domestic supply well screened in the fluvial deposits is approximately 6,000 feet north-northwest of the apron area and is inactive.

The source areas for VOC contaminants appear to be small and overlapping from different contaminant types. A source of chlorinated hydrocarbons was not identified in the unsaturated zone, and concentrations in groundwater were not indicative of a DNAPL source area. The most prevalent chlorinated hydrocarbon identified was TCE, which exceeded its MCL in the upper, middle, and lower parts of the fluvial deposits. VOCs and inorganics were identified in the loess in concentrations exceeding regulatory standards. The presence of these contaminants in the loess is attributable to residual contamination as a result of downward migration; the inorganics probably are naturally occurring.

The Cockfield Formation was also evaluated for the downward migration of contaminants from the fluvial deposits. VOCs were detected in Cockfield Formation groundwater during the first sampling event, but have not been detected in subsequent events. This indicates that the contaminants were likely introduced during drilling activities. Data collected during the RFI indicate that most groundwater contaminants were identified in the fluvial deposits, and the potential for further downward contamination to the Memphis aquifer is unlikely given the absence of contamination and the physical properties of the Cockfield Formation. To further support the conclusion that there is no hydraulic connection between the fluvial deposits and the Memphis aquifer, groundwater samples collected from the Memphis aquifer at the apron area were free of VOCs and tritium.

Hydrogeology and Ground-Water Quality at Naval Support Activity Memphis, Millington, Tennessee

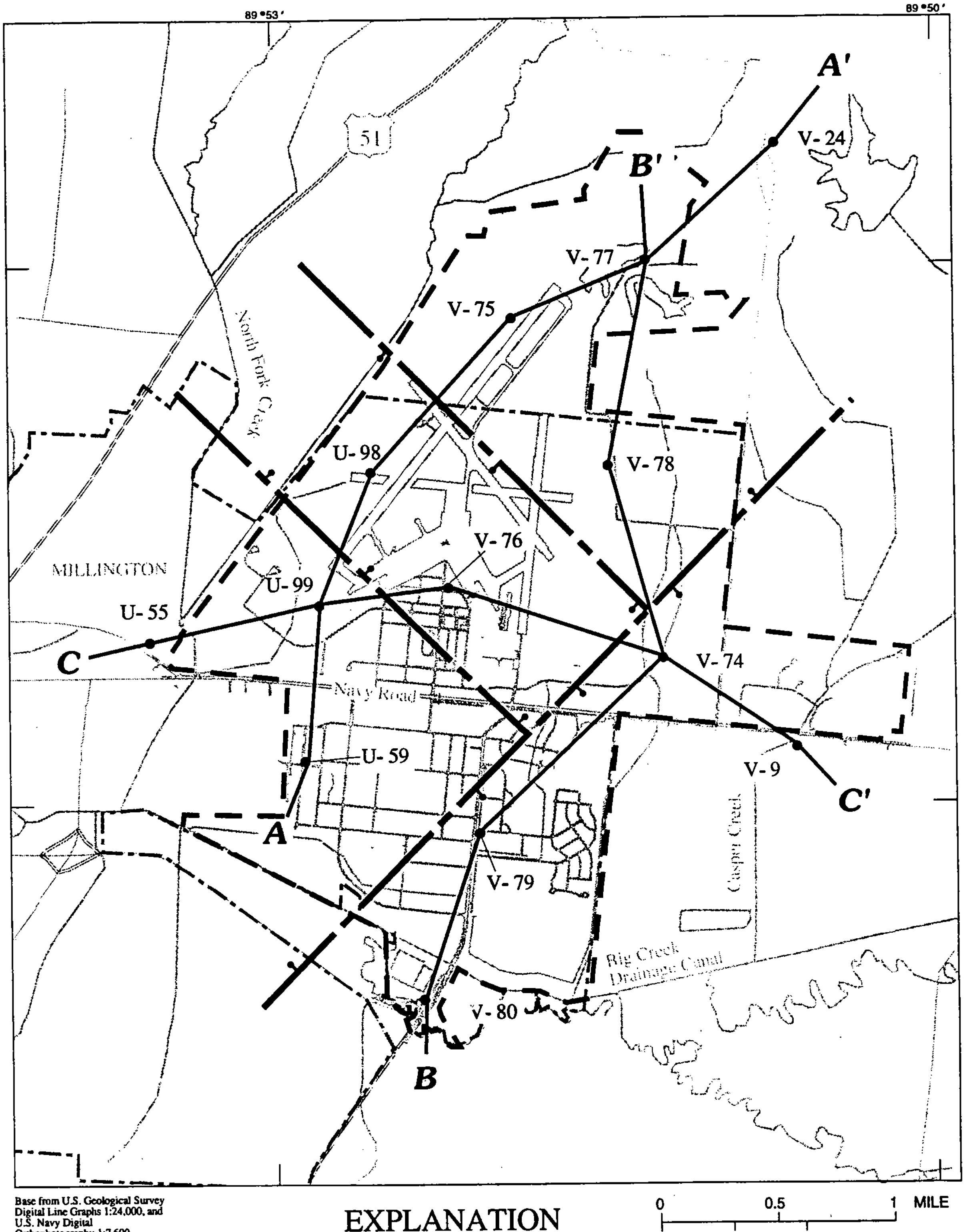
Water-Resources Investigations Report 97-4158



Prepared by the
U.S. GEOLOGICAL SURVEY

in cooperation with the
DEPARTMENT OF THE NAVY,
SOUTHERN DIVISION,
NAVAL FACILITIES ENGINEERING COMMAND

from Carmichael et al., 1997

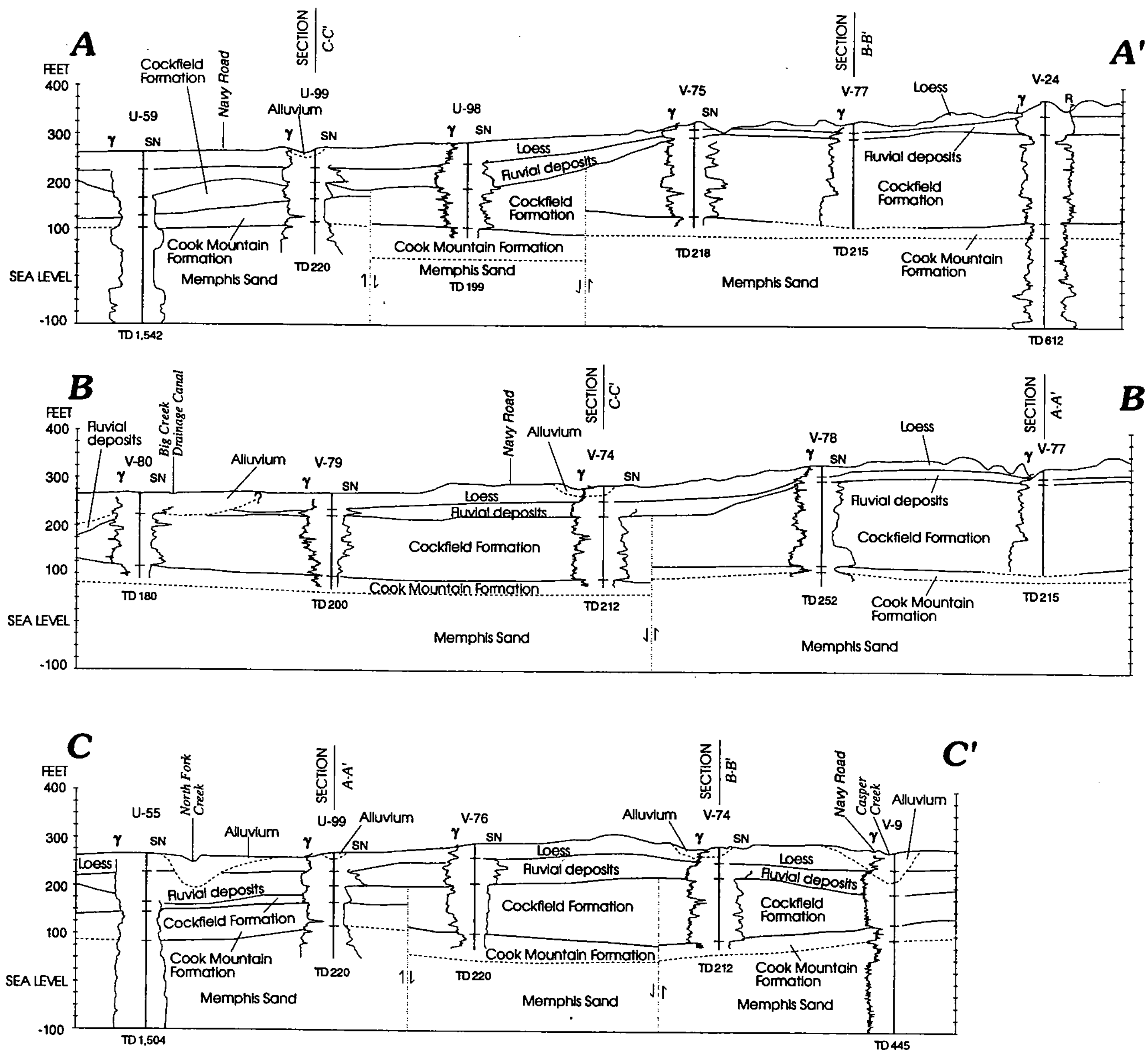


EXPLANATION

- NAVAL SUPPORT ACTIVITY MEMPHIS BOUNDARY
- MILLINGTON CITY BOUNDARY
- APPROXIMATE LOCATION OF FAULT LINE WITH BALL AND BAR INDICATING DOWN-THROWN SIDE
- A —— A′ HYDROGEOLOGIC SECTION
- U-55 ● WELL USED FOR HYDROGEOLOGIC SECTION -- Number is Sh (Shelby County) number (Sh:U-55)

Figure 4a. Locations of hydrogeologic sections *A–A′*, *B–B′*, and *C–C′*, and faults that displace the Cockfield Formation, Cook Mountain Formation, and Memphis Sand at Naval Support Activity Memphis.

from Carmichael et al., 1997



Modified from Carmichael and others, 1997

VERTICAL EXAGGERATION X 10

0 0.5 1 MILE

0 0.5 1 KILOMETER

EXPLANATION

A——A' GEOLOGIC SECTION

FORMATION CONTACT. DASHED WHERE APPROXIMATE

APPROXIMATE LOCATION OF FAULT, AND RELATIVE DIRECTION OF DISPLACEMENT

V-79 TEST HOLE OR WELL – Number is Sh (Shelby County) number (Sh:V-79). Tick marks indicate formation contacts

TD200 TOTAL DEPTH OF WELL OR TEST HOLE

GEOPHYSICAL LOGS

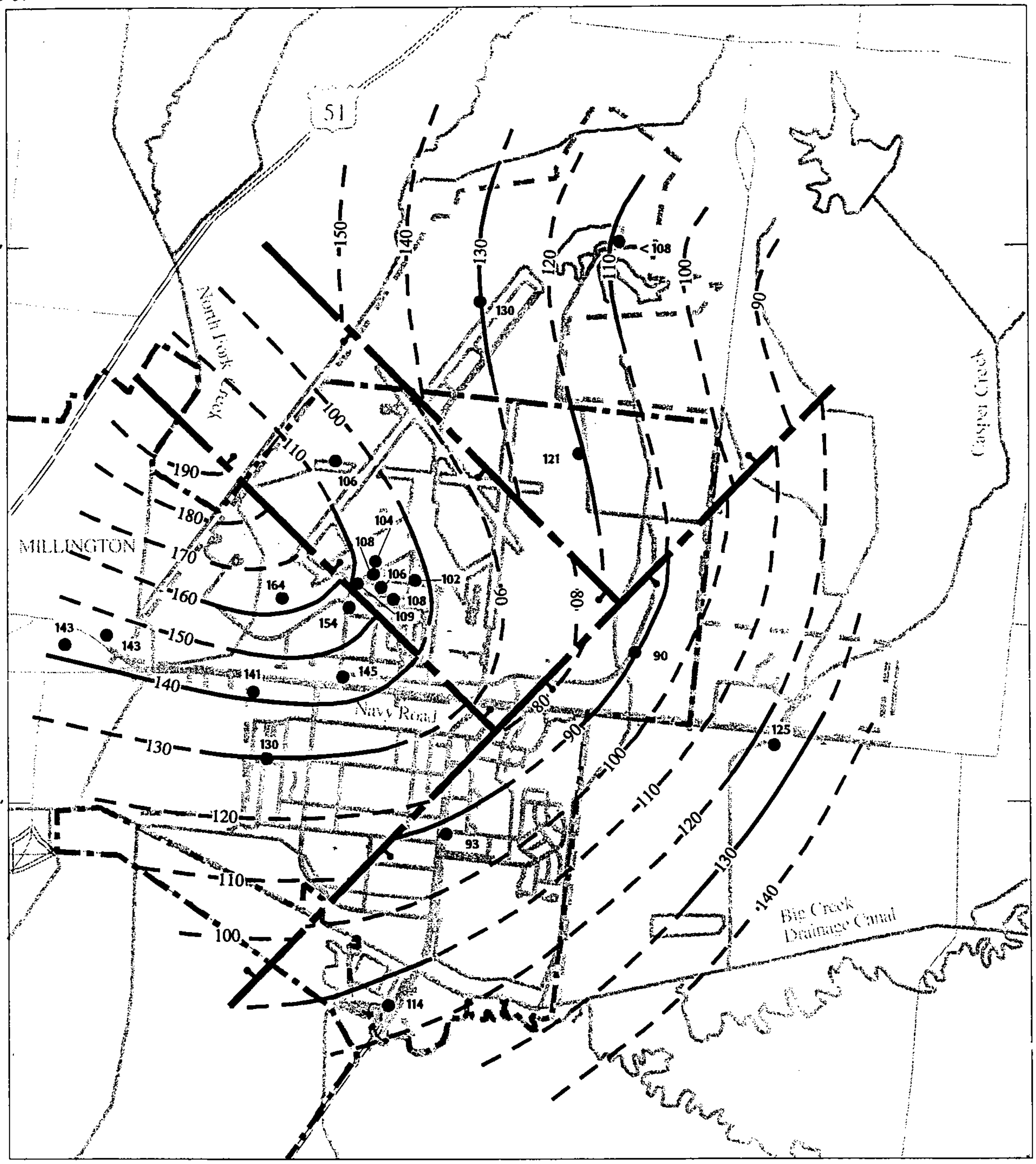
γ GAMMA-RAY LOG

SN SHORT-NORMAL RESISTIVITY LOG

R RESISTANCE LOG

Figure 4b. Geologic sections *A-A′*, *B-B′*, and *C-C′*, and geophysical logs of test holes or wells in the area of Naval Support Activity Memphis, Millington, Tennessee.

from Carmichael et al., 1997



EXPLANATION

NAVAL SUPPORT ACTIVITY MEMPHIS BOUNDARY

MILLINGTON CITY BOUNDARY

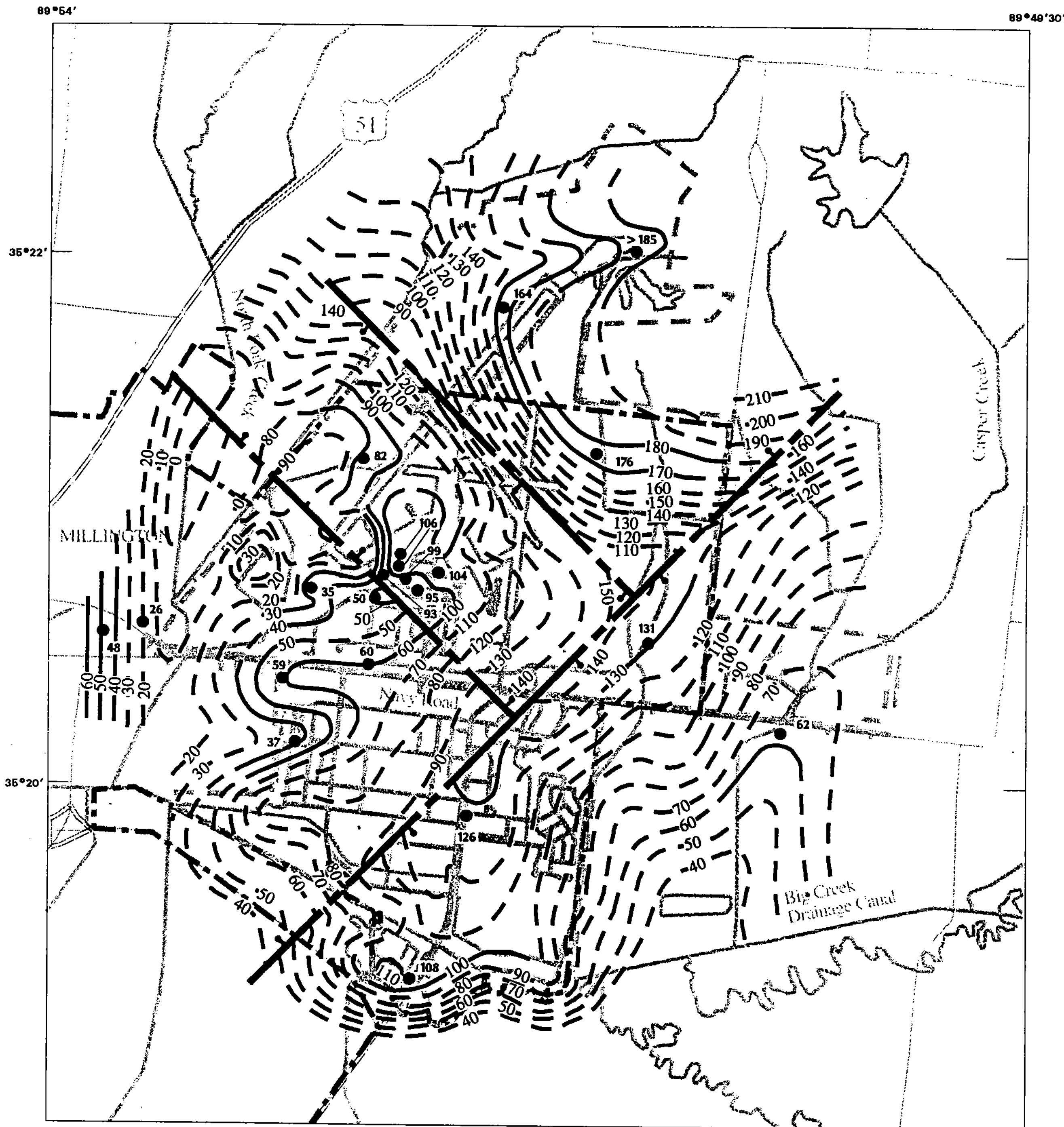
140 SUBSURFACE CONTOUR -- Shows altitude of base of Cockfield Formation (top of Cook Mountain Formation). Dashed where approximate. Datum is sea level. Contour interval 10 feet

APPROXIMATE LOCATION OF FAULT WITH BALL AND BAR INDICATING DOWN-THROWN SIDE

130 WELL -- Number is altitude, in feet, of base of Cockfield Formation (top of Cook Mountain Formation). Datum is sea level

Figure 13. Altitude of base of Cockfield Formation (top of Cook Mountain Formation) and locations of faults that displace these formations at Naval Support Activity Memphis.

from Carmichael et al., 1997



Base from U.S. Geological Survey Digital Line Graphs 1:24,000 and U.S. Navy Digital Orthophotography 1:7,600

0 0.5 1 MILE
0 0.5 1 KILOMETER

EXPLANATION

NAVAL SUPPORT ACTIVITY MEMPHIS BOUNDARY

MILLINGTON CITY BOUNDARY

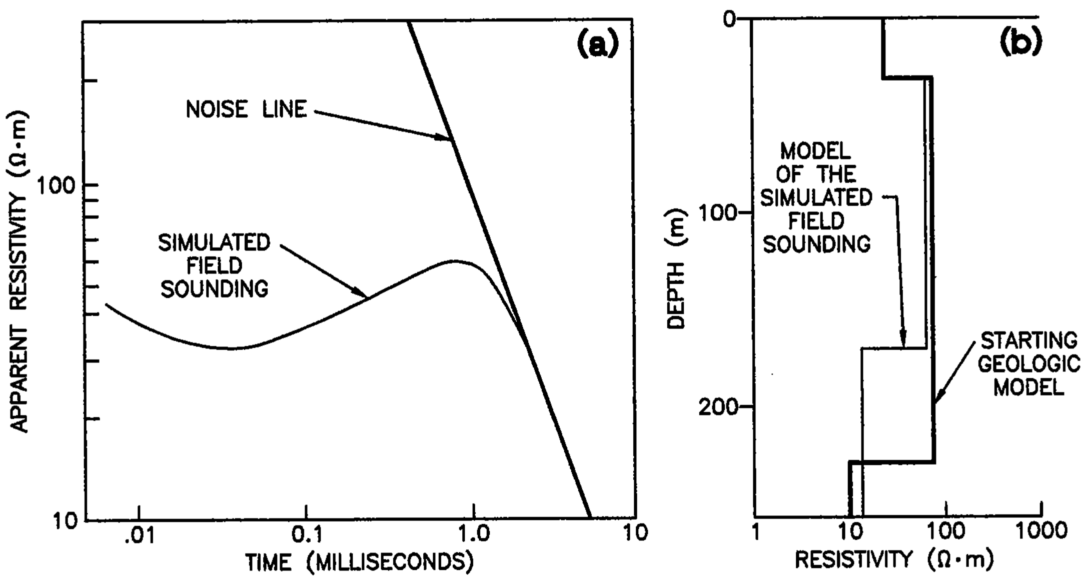
—60— — LINE OF EQUAL THICKNESS OF THE COCKFIELD FORMATION -- Number is thickness. Dashed where approximate. Datum is sea level. Contour interval 10 feet

APPROXIMATE LOCATION OF FAULT WITH BALL AND BAR INDICATING DOWN-THROWN SIDE

● 48 WELL -- Number is thickness, in feet, of the Cockfield Formation

Figure 14. Thickness of the Cockfield Formation and locations of faults that displace the Cockfield and Cook Mountain Formations at Naval Support Activity Memphis.

from Carmichael et al., 1997



RCRA FACILITY INVESTIGATION
NAVAL SUPPORT ACTIVITY
MID–SOUTH
MILLINGTON, TN

FIGURE G–8
INFLUENCE OF NOISE ON DEPTHS
PREDICTED BY A TEM MODEL

DWG DATE: 02/03/00	DWG NAME: 0094G016

Appendix G

Joint Geophysical and Geological Interpretation of Subsurface Geology

APPENDIX G

Joint Geophysical and Geological Interpretation of Subsurface Geology, Naval Support Activity Memphis, Millington, Tennessee

In support of a RCRA Facility Investigation

CTO-094, contract No. N62467-89-D-0318

for:

The Department of the Navy

Southern Division Naval Facilities Engineering Command

North Charleston, South Carolina

by:

EnSafe Inc.

5724 Summer Trees Dr., Memphis, TN 38134 · (901)372-7962

February 17, 2000

Table of Contents

List of Figures

List of Tables

List of Plates

Executive Summary

In support of environmental investigations at Naval Support Activity Mid-South, EnSafe has completed a joint geophysical and geological investigation to evaluate potential pathways for contaminant transport from a shallow fluvial-deposits aquifer to a deeper drinking water supply in the Memphis Sand aquifer. Separating these two aquifers is the Upper Claiborne confining unit, consisting of silts, clays, and sands of the Cockfield Formation and clays of the Cook Mountain Formation. The study, based on geophysical and geological data, suggests that the confining unit is contiguous throughout the study area and does not have windows or significantly thin zones.

The study shows a possible paleo-erosional channel at the top of the Cook Mountain Formation, meandering in a roughly north-south trend. The paleo-erosional channel model disagrees with an earlier model interpreted by the USGS, which postulates a faulted graben feature. Both structural models fit the geological data reasonably well and are plausible. However, the fault model better explains an apparent hydrologic leakage pattern in the fluvial deposits aquifer. The leakage pattern is inadequately characterized, and confirmation would be needed to decide which geologic model is correct.

G.0 INTRODUCTION

In the mid-1990s, environmental investigations at Naval Support Activity (NSA) Mid-South began to identify specific areas where the shallow fluvial deposits aquifer has been impacted by solvents and benzene. Although this aquifer is not a significant water resource in this area, major drinking water aquifers lie below it, separated by a 100- to 200-foot-thick confining layer of clay, silt, and sand. The overall question addressed on this project is: does this confining layer protect the deeper aquifers from downward transport of shallow contamination? The present geophysics study addresses the *geological* aspects of this question, specifically: is the confining layer continuously present at NSA Mid-South, and are there thinnings, windows, faults, or other geologic features that would cause concern? The second aspect of the problem — how resistive the layer is to contaminant movement from a *chemical* standpoint — will be addressed in an upcoming corrective measures study.

To answer the geologic questions, a facility-wide geologic mapping effort was begun in 1994. At that time, only limited stratigraphic information was available for geologic units deeper than 50 feet. The USGS had been tasked to install five stratigraphic test borings at widely spaced positions across the facility to establish deeper information. However, it was recognized that these borings, though essential to the ongoing environmental investigation, were so widely spaced that small-scale structure could be missed on this 3,490-acre property. To supplement the drilling information, a geophysics investigation was conducted.

The specific objectives of the geophysics work were to:

- Integrate the geophysics results with previous drilling data and other information to interpret a coherent geologic conceptual model of the area.

- Evaluate stratigraphic features important to contaminant movement.

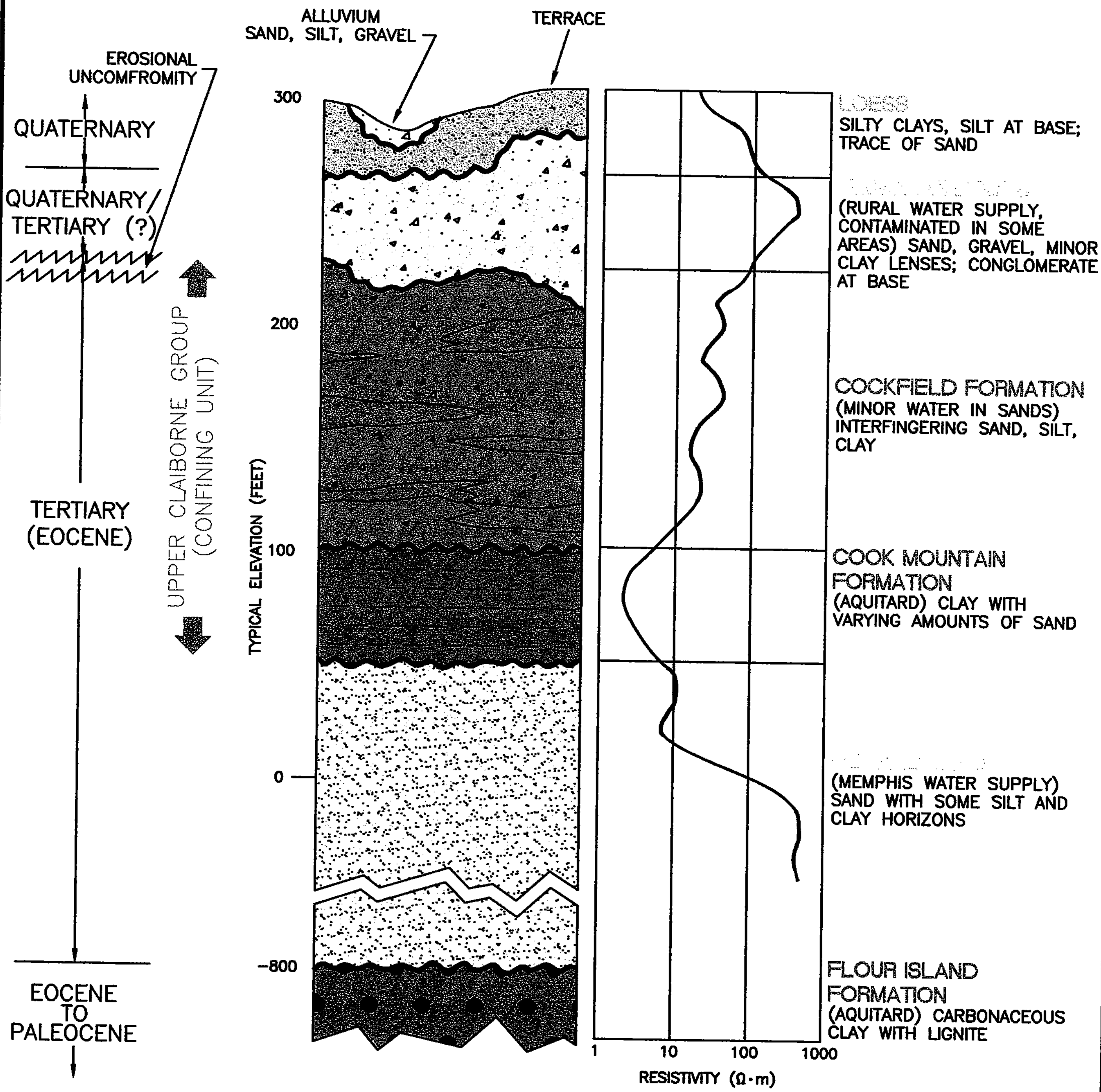
- Determine if faulting exists and how it might affect contaminant movement.

Several geophysical techniques address these kinds of objectives: reflection seismics, audio-frequency magnetotellurics (AMT, or its controlled source version, known as CSAMT), and transient electromagnetics (TEM, sometimes called time-domain electromagnetics, or TDEM). Each has strengths and weaknesses. Factors which affected the choice of technique included the large area of the site, the need for information between 10 and 300 feet below grade, geophysical noise sources, and the expected electrical and density aspects of the relevant geologic units. Based on these considerations, TEM was selected as the best combination of technical effectiveness and cost.

G.0.1 Geologic Application

The success of TEM is critically dependent on resistivity contrast patterns associated with geologic units. Figure G-1 generically illustrates the main geologic formations and their associated resistivities within the depths of interest. These formations are the top part of a 2,500-foot thick sequence of unconsolidated and semiconsolidated sediments overlying Paleozoic bedrock (Carmichael et al., 1997).

The primary interest of this study is the Upper Claiborne Group, a confining unit that separates the contaminated fluvial deposits aquifer from the drinking water supplies in the deeper Memphis Sand and Fort Pillow formations (the latter is below the maximum depth shown in Figure G-1). The Upper Claiborne Group consists of two relatively distinct formations: The Cockfield Formation, which is mostly silt and clay, but locally has extensive sands; and the Cook Mountain Formation, which is mostly clay and silty clay. Both units have erosional upper



RCRA FACILITY INVESTIGATION
NAVAL SUPPORT ACTIVITY
MID–SOUTH
MILLINGTON, TN

FIGURE G–1
TYPICAL SHALLOW GEOLOGY AND GEOPHYSICAL RESPONSES

DWG DATE: 01/27/00	DWG NAME: 0094G015

This page intentionally left blank.

and lower contacts and they vary in thickness, elevation, and lithology. To understand the spatial relationships of these variations is the specific objective of this study.

When the work was first undertaken in 1994, little direct information was available on the resistivity responses of these formations. However, the clays present in these units (particularly the Cook Mountain Formation) and other work in this region of the state (Hoekstra et al., 1992) suggested that there would be sufficient electrical contrast to detect these units. After the geophysics project was underway, five stratigraphic test holes were drilled and logged. Resistivity logs showed a complex resistivity structure that varied from hole to hole, but confirmed that theCook Mountain Formation had a moderately favorable electrical contrast for detection with TEM in most areas. The Cockfield Formation, however, did not have a consistent electrical signature due to its more variable lithology; hence it is a poor target for TEM.

This page itnentionally left blank.

G.1 DESCRIPTION OF TEM TECHNOLOGY

SECTION G.1 SUMMARY

This section presents some background information on how TEM works, how the data are plotted and interpreted, and some of the pitfalls that can confuse the interpretation. The discussion is foundational for evaluating data quality (Section G.3), but may be skipped if your only interest is in the interpreted geology (in which case, please skip to Section G.4).

TEM is a commonly used geophysical technique with environmental and energy-exploration applications. It works by transmitting a pulse of electrical current into the ground and measuring the response by a sensor laid on the ground. If electrical conductors such as clays or water-saturated silts are present, the current flows into them more easily than through non-conductive geology, much as current flows more readily through copper wiring than through its insulation. When the current finds a conductor in the ground, the measured signal is stronger than in areas where the conductor is absent. Thus, by plotting the signal strength as a function of its penetration depth into the ground and location within the site, one can construct a three-dimensional map of conductive and resistive layers. With care, these maps can be converted into a map of subsurface geology.

TEM interpretation can be confused by two important problems. *Culture*, defined as above- and below-ground structures such as pipes and rebar, can distort the signal and a bad interpretation can result. *Signal depletion* occurs as the signal weakens with depth; without sufficient care, a false conductive layer can be interpreted. These problems are combatted by applying specific tests to the data. In addition, certain resolution limitations must be remembered when interpreting the data. Generally, TEM maps conductors better than it does resistors, and depths to interfaces may have an error of about $\pm 15\%$ of the actual depth.

G.1.1 How TEM Has Been Used in Past Investigations

Initially developed for deep investigations for mining, TEM has become an important "niche" tool for certain types of environmental investigations. Typical published applications include mapping groundwater (Taylor et al., 1992; Auken et al., 1994), identifying naturally occurring degradation of groundwater quality (McNeill, 1990 summarizing Fitterman, 1986; Stewart and Gay, 1981; Fitterman and Hoekstra, 1982; Hoekstra et al., 1992b; Mills et al., 1988; Goldman et al., 1991; Christensen, 1995), and mapping increased groundwater salinity due to contaminant sources (Buselli et al., 1986, 1990; Fitterman et al., 1990; Hoekstra and Blohm, 1990; James and Borns, 1993; Hoekstra et al., 1992; Hanson et al., 1993; Sinha, 1993; Hughes, 1995). TEM has also been used to map stratigraphy and structure (Hoekstra et al., 1992; Christensen, 1995; Chen, 1998). Many examples of geologic mapping applications have come from mining and petroleum exploration (see Spies and Frischknecht, 1991, and Nabighian and MacNae, 1991, for a review and bibliography).

G.1.2 How TEM Works

There are many variations in how TEM is used, depending on the objectives and site characteristics. Environmental applications often employ a central loop configuration for the measurements. For this configuration, a *source loop*, typically a small wire arranged in a square shape approximately 5 to 100 meters on each side, is laid out on the ground. An alternating current is transmitted into the source loop. Whenever the current polarity is switched, an electromagnetic pulse is generated in the loop. The pulse enters the ground and propagates downward, like a "smoke ring" emanating from the source loop (Nabhigian, 1979; Figure G-2). Shortly after the current pulse ("early time"), the smoke ring is small and strong, and is concentrated in the shallow subsurface beneath the source loop. After some elapsed time ("intermediate time"), the smoke ring has traveled downward, weakening and increasing in size. After an even larger elapsed time ("late time"), the smoke ring has weakened considerably and is broad and diffuse. Finally, at some depth determined by equipment and ground conditions, the smoke ring becomes undetectable.

The downward-traveling smoke ring can be thought of as a ring of current, called an "equivalent current loop," illustrated by the arrowed circles in Figure G-2. An electromagnetic field propagates in all directions away from the equivalent source loop, resulting in a voltage gradient at the surface as an instantaneous response to the smoke ring. By placing a *receiving loop* at the

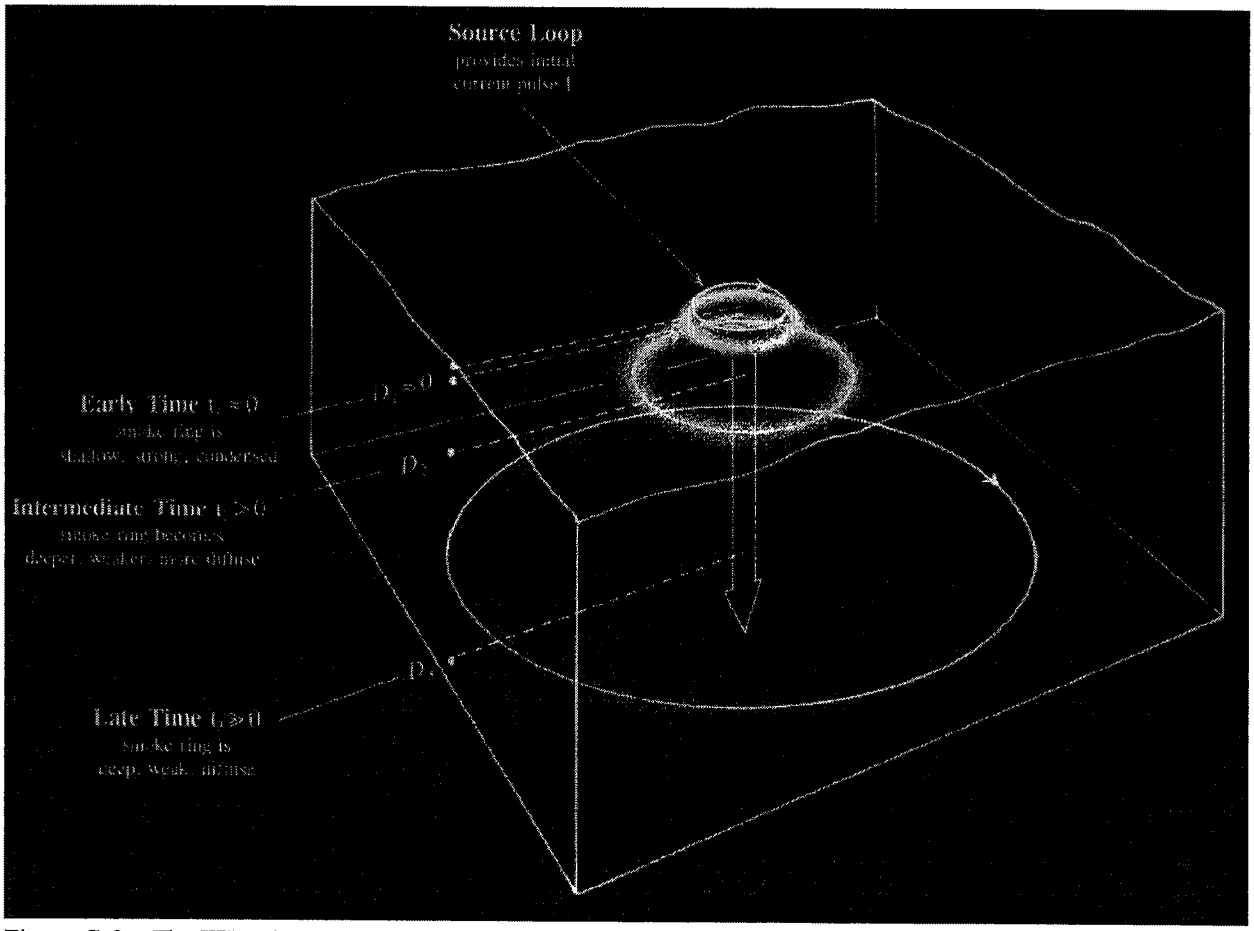


Figure G-2. *The TEM signal can be visualized as a "smoke ring" of current traveling downward into the ground, becoming weaker and broader with depth.*

surface, one can monitor how the smoke ring behaves over time as it moves through the ground. This behavior gives valuable information about subsurface structure.

The received signal can be formalized by writing the voltage V as a time-dependent change of the vertical magnetic field h_z ($V = \partial h_z / \partial t$). The general equation can be simplified in the two cases of early-time (small t) and late-time (large t) measurements. For early time, the expression is

$$\frac{\partial h_z}{\partial t} = \frac{-3I\rho}{\mu_0 A^3}\ , \tag{G-1}$$

and for late time, the expression is

$$\frac{\partial h_z}{\partial t} = \frac{-IA^2\mu_0^{3/2}}{20\pi^{1/2}t^{5/2}\rho^{3/2}}\ , \tag{G-2}$$

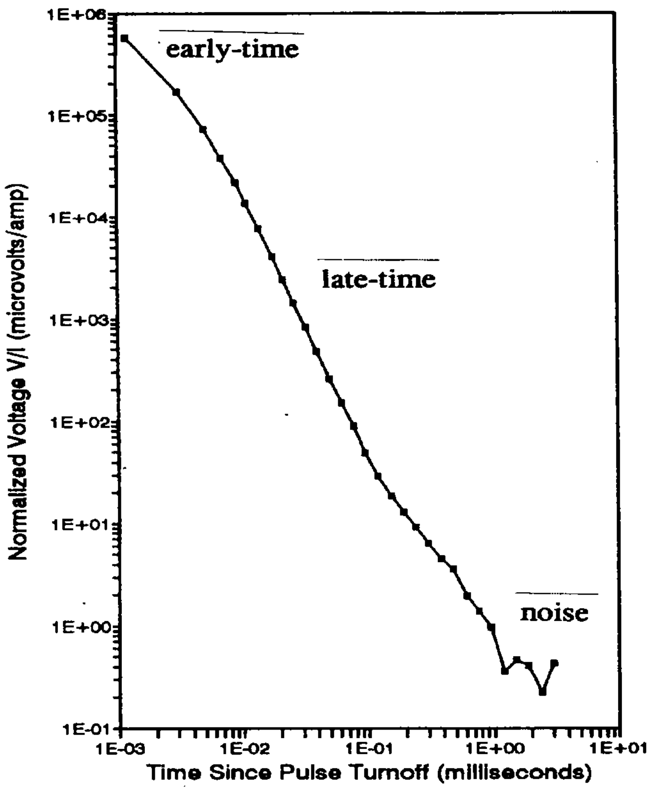
where: I = the current flowing in the loop (amperes), A = the area of the loop, μ_0 is the free-space magnetic permeability, and ρ = the resistivity of the ground in ohm-meters ($\Omega \cdot$m). The governing equations differ because early-time measurements are influenced by effects from the original current source, whereas late-time measurements respond to induced eddy currents in the subsurface after the source current has dissipated.

The declining voltage, plotted as a function of elapsed time since the current pulse, is known as a *decay curve* (Figure G-3). The decay curve is sampled in discrete time intervals called *windows*. In the earliest windows, the early-time response of equation (G-1) prevails, and the decay curve is flat (not a function of time t). The flat response indicates that the return signal is still dominated by the original current pulse. Thus, most measurement windows are concentrated in the late time part of the curve, which best characterizes subsurface resistivity changes.

Signals decay within a matter of milliseconds in the earth, and the rate of decay depends mainly on the subsurface electrical resistivity. If the resistivity is high, current flow is impeded, and the electromagnetic energy is dissipated as heat. Thus, a resistive earth causes a rapid voltage decrease in the decay curve. In the case of a conductive earth, current flows more freely, less energy is dissipated, and the decay curve is less steep. Thus, just as copper wiring is more

Figure G-3

Typical TEM Decay Curve



efficient for transmitting current than aluminum because copper is a better conductor, a conductive earth is a more efficient medium for current flow than a resistive one.

Because the decay rate depends on resistivity, so does the steepness of the decay curve. High resistivities yield steep decay curves and low resistivities shallow ones. If layers of several resistivities are present, the slope will change in response to them. Consider, for example, a conductive geologic layer, such as a clay, buried 100 feet in an otherwise resistive, homogeneous earth. As the smoke ring leaves the source loop and starts its downward path, it "sees" only the resistive surface, and the voltage decay measured in the receiving loop is steep. But as the smoke ring moves deeper, it encounters the conductive layer, and current flows preferentially through that layer. A higher received voltage is sustained in late time, and the voltage decay curve goes from steep to shallow. Finally, if the signal is strong enough, the smoke ring "breaks through" the conductive layer and senses the resistive material below it, and the voltage decay becomes steep again. Thus, the change in the decay curve can be interpreted for the presence of the conductive layer. Further, since the effective depth of the smoke ring is a function of resistivity and the elapsed time since the current pulse, the depth of the conductive layer can also be estimated.

The resistivity-dependent decay rate determines how deeply the TEM signal penetrates at any given time:

$$D = 0.89\sqrt{\rho t_{\mu s}}\ , \qquad \text{(G-3)}$$

where D is the effective depth and time $t_{\mu s}$ is in units of microseconds. Hence, the more conductive the earth, the less deeply TEM can see because current tends to reside with a conductor (a process called current channeling) and does not readily penetrate through it. In the extreme case of a perfect conductor, currents would concentrate on its' surface, not within the conductor itself, and penetration would be zero.

While equation G-3 might suggest an unlimited range of vertical resolution, both the shallow and deep limits of the curve are set by instrumentation and field noise considerations. The shallowest limit is determined by how fast the source signal can be turned off, which is typically about 1 to 10 microseconds, placing the first window several meters deep. The maximum depth at which a signal can be measured depends on the signal-to-noise ratio of the measurement system, which is described in Section G.1.7; portable systems of the type used on environmental surveys achieve penetration to 20 to 100 meters, but larger systems can penetrate to 10 kilometers or more.

G.1.3 Measurement Procedure

TEM data are acquired by laying out a source loop or grounded dipole, into which currents of milliamperes to 100 amperes are transmitted; voltages are sensed in a separate receiving loop. Many arrangements are possible for the source and receiving loops, but the most common for shallow investigations is the central-loop array, which places a small receiving loop at the center of a larger source loop. The sizes depend on the depth required and the physical constraints of the site. Voltages are sensed at 20 to 40 time windows by a digital receiver. A single decay trace can be acquired in a small fraction of a second, but many must be acquired, added ("stacked" in geophysical parlance), and averaged to suppress random noise. The process takes a few minutes for each sounding.

G.1.4 How TEM Responds to Geology

Electrical conduction in the earth is primarily controlled by the availability of exchangeable cations in a liquid. Thus it is not unexpected that dry earth materials tend to be resistive, while those containing water are more conductive. However, several factors control the conductivity of materials containing water. *Porosity* is an important control, since it determines the amount of fluid the material can contain, and thus the material's ability to exchange available cations. Permeability is also of some importance in certain instances. The degree of pore saturation is clearly an important factor as well. Some materials are only partly saturated due to low permeability or other factors. For example, vadose-zone soils may be slightly moist due to downward percolation or capillary effects from deeper groundwater. *Cation availability* is critically important. The soil or rock matrix is the chief contributor to available cations. For example, a fresh basalt has few cations to exchange, and hence is resistive. On the other hand, weathered clays, by virtue of their chemistry and extensive pore path network, contribute a large number of cations to pore fluids, making them conductive. The type of clay, its degree of weathering, and the particular geometry of its pore spaces will also influence the conductivity. Cation availability is also affected by sources outside the soil-rock matrix, such as introduced chlorides or acids from contaminated sites, incursion of coastal brines into an aquifer, etc. In rare cases, such as porphyry copper deposits, the presence of *conducting metals* may also influence ground conductivity. A more common source of metals on environmental surveys are man-made utilities. Other controls, such as temperature, inclusion of organic matter, and biologic activity may act as secondary controls.

In near-surface environmental investigations, the earth's electrical response is often dominated by the presence of saturated zones (or depth to water in simple cases) and the presence of saturated clays. These factors provide valuable marker horizons in characterizing shallow hydrology and geology.

G.1.5 Limitations of TEM

As with any investigative technique, TEM has certain limitations that must be considered in the interpretation process. The chief ones relevant to this investigation are:

- TEM is more effective in mapping conductors than resistors.

- The resistivity of a resistive unit is poorly determined. In this data set, for example, models are very sensitive to minute changes in a conductive layer (e.g., less than 1 $\Omega \cdot m$), but less sensitive to relatively resistive units (more than 10 $\Omega \cdot m$). Modeled resistivities for a 100 $\Omega \cdot m$ layer can vary by an order of magnitude without seriously affecting the quality of the solution.

- The resistivity and thickness of a thin conductive layer are poorly resolved. Each parameter is unstable and can vary unrealistically in the modeling process. In other words, a model with an ultra-thin, conductive layer will fit the data as well as one with a thin, ultra-conductive layer. A more stable parameter is the modeled thickness of the layer divided by the resistivity, which is called *conductance*. This parameter better estimates the effect of a thin conductor on the measured resistivity curve.

- Resolution is limited. A TEM sounding can be thought of as a "fuzzy" borehole electric log. Whereas a borehole log resolves small-scale features over a small distance from the borehole wall, the TEM sounding sees larger-scale features (usually conductors) with vertical dimensions of ten to several hundred feet. TEM requires a target to have a clear resistivity contrast and sufficient thickness to be detected. If several resistivity changes occur with depth, they might be unresolved, and the TEM model will simply compute an average. Some examples are shown in this report. Resolution decreases with depth, as can be appreciated by the larger smoke ring at depth in Figure G-2.

- Limited resolution means that depths to layers will have significant uncertainties, depending, in part, on the depth of the interface. Typically the top of a conductive layer can be located to within $\pm 15\%$ of its depth of burial; the error in picking the top of a resistor may be larger.

- Modeling errors (false layers, incorrect interface depths, incorrect resistivities) can arise from signal depletion and cultural effects, as described below. These can be the most serious problems for TEM, and must be carefully evaluated.

G.1.6 Cultural Effects

Utilities and other man-made structures which disrupt the TEM signals and interfere with the interpretation of subsurface geology are known as *culture*. At industrial sites, culture is the most serious limitation for TEM, producing two types of effects: data scatter and data biasing.

Data scatter is produced by power lines and other signal sources which produce or carry electromagnetic signals in the spectral range at which measurements are obtained. Examples include high-order harmonics of the 60 Hertz (Hz) powering frequency, communication signals, and cathodic corrosion protection on some underground steel pipes. The frequencies of most of these signals are regulated only to within a few percent and amplitudes can vary significantly, resulting in data scatter. If the noise is random, it is overcome by increased stacking and averaging; if noise is periodic, it can sometimes be removed by filtering.

Data biasing is by far the most difficult problem caused by culture. Bias is caused when the TEM signal couples into metal culture and flows preferentially along it. Without sufficient care, the resulting data might be erroneously interpreted as a conductive layer.

Although culture is an important problem in TEM interpretation, it has been virtually ignored in the literature. There are no standard techniques for identifying or dealing with cultural influences. The conventional wisdom is to not obtain data near culture, but "near" has not been defined, and avoidance is a near impossibility at many environmental site investigations. The practical problem then boils down to recognizing the effects of culture so that the data are not wrongly interpreted.

Figure G-4 illustrates three types of cultural problems, drawn from the present data set: (a) unusual noise; (b) bumps in the decay curves; and (c) unrealistic transient changes over short distances.

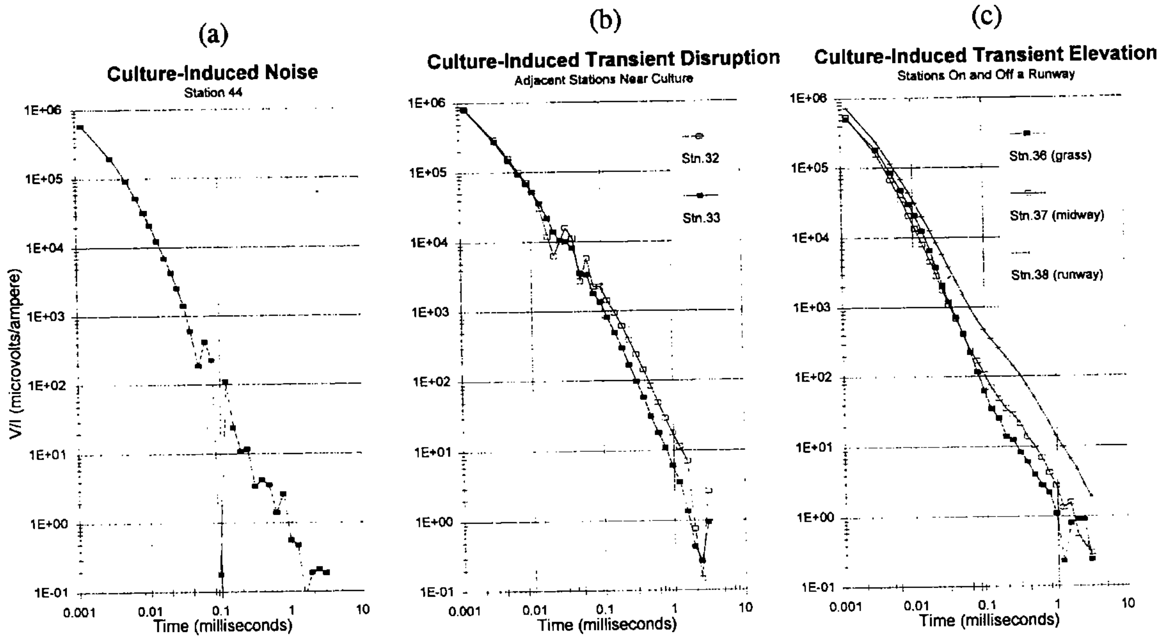


Figure G-4. *Different types of noise caused by culture.*

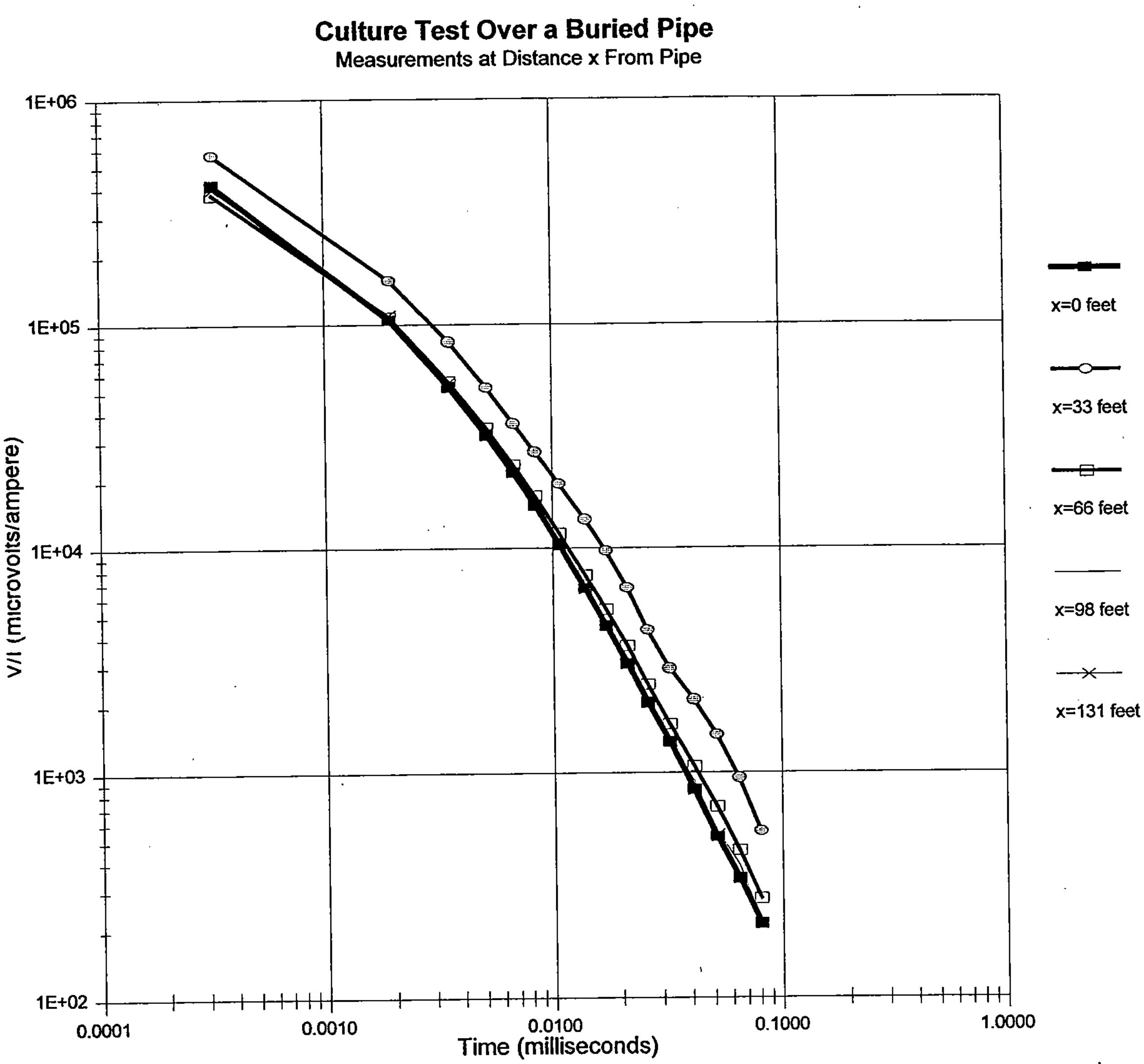
Figure G-4 shows station 44, which was overwhelmed by high-frequency noise (presumably from a transmitter 1,500 feet to the northwest). Noise of this type indicates a nearby cultural feature; even if the noise could be defeated by filtering and signal stacking, its presence would suggest that the interpreter should carefully evaluate data bias in the noise-suppressed data.

Figure G-4 shows less noisy data but odd disruptions in middle times. The data are from adjacent soundings in a grassy area with an apparent metal water line nearby. Judging by the disruptions, station 32 appears to be closer to the pipe than station 33. Note the elevation of the late-time transient from station 32.

Figure G-4c shows three adjacent soundings in a traverse from grass to a steel-reinforced taxiway with imbedded steel tiedown hooks. As the TEM array moves onto the taxiway, the decay curve shifts upward, especially in mid and late times. The taxiway, with its metal content, acts as an extended conducting sheet. Note the absence of disruptive notches in mid-times, which would have been a definitive indication of culture. Note also that the upward-shifted transient at station 38 is actually less noisy because of a higher signal-to-noise ratio because its signal is stronger in late time; thus the most culturally affected station can appear to be the least noisy in late time. Without sufficient care, one might erroneously interpret these data as a change to more conductive ground beneath the taxiway. In this case, one would note the strongly elevated transient with respect to nearby stations (with characteristic noise suppression in late time) and unrealistically low resistivities required by the model, concluding that stations 37 and 38 are biased by culture.

How close to culture can TEM measurements be made? No applicable studies have been published, other than a brief example by Fitterman et al., (1990). An unpublished study by EnSafe was done over a 2-inch pipe buried 2 feet deep in a pristine desert area near Tucson, Arizona. Figure G-4 shows the transients from a 20-meter transmitting antenna at various distances from the pipe (measured from the pipe to loop center). The array and instrumentation are identical to those used at NSA Mid-South. The study shows that data return to a "background" response approximately 40 feet from the pipe. Of course, this distance will vary with specific field situations, and dependence on loop size is under investigation. Early results suggest that influences from culture more than two loop sizes away from the transmitting loop is negligible.

Figure G-5


Culture Test Over a Buried Pipe
Measurements at Distance x From Pipe
1E+06
1E+05
1E+04
1E+03
1E+02
V/I (microvolts/ampere)
0.0001
0.0010
0.0100
0.1000
1.0000
Time (milliseconds)
x=0 feet
x=33 feet
x=66 feet
x=98 feet
x=131 feet

This page intentionally left blank.

A final question is: can the imprint of culture be removed from data to reveal hidden structure? Figure G-6 shows smooth-modeled resistivity data from the Arizona test data (see Section G.2.2 for more information on modeling). The results are presented in downhole log fashion; conductive and resistive horizons, picked at the inflection points of the soundings, are assigned letter designations for clarity. The center zone within approximately 13 meters of the pipe shows disrupted soundings, and the nominally horizontal conductive and resistive "contacts" show a double-winged pattern symmetrical about the pipe. Interestingly, the data are less disrupted when

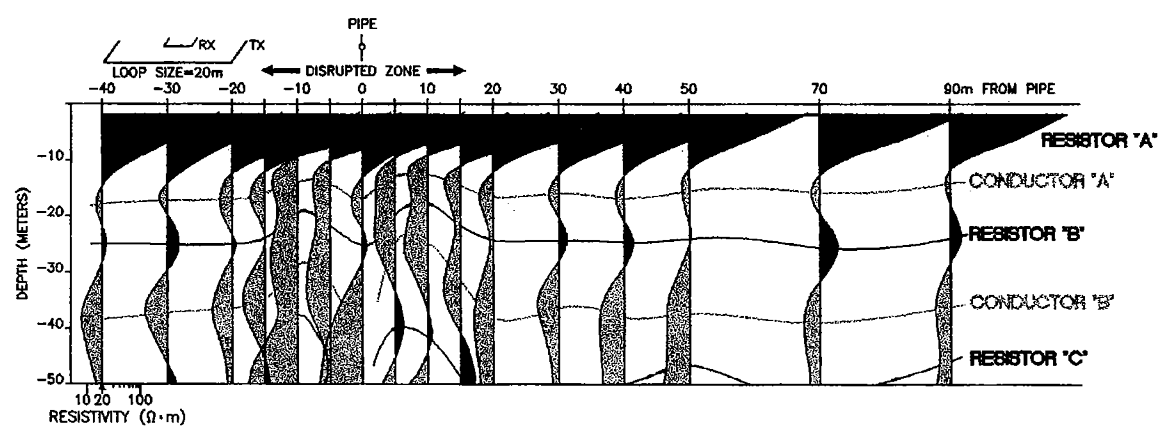


Figure G-6. *TEM test data over a buried pipe in Arizona, from unpublished EnSafe data.*

the loop is centered over the pipe, than when a loop edge is on the pipe. Despite the disruptions, it is noteworthy that each "contact" is readily mappable at and near the pipe, though both absolute resistivity values and contact depths would be erroneous. In other words, cultural effects, instead of rendering data useless, may merely mask useful information. If this is confirmed, a "culture correction" may be possible.

These issues are a worthy topic of research. Meanwhile, it is necessary to reject data with obvious cultural bias.

Identifying cultural problems — The following tests may be applied to identify soundings affected by culture:

Test 1: Is any part of the sounding loop within two loop sizes of a known cultural feature?

Test 2: Does the sounding have mid-time bumps or unusual early- to mid-time noise?

Test 3: Does the late-time transient elevate above the expected response and is it accompanied by noise suppression?

Test 4: Do the 1D models return unrealistic resistivities or fail to match changes observed in the field data?

Test 5: Is the sounding significantly different from nearby soundings and exceed differences attributable to small-scale geologic changes or noise?

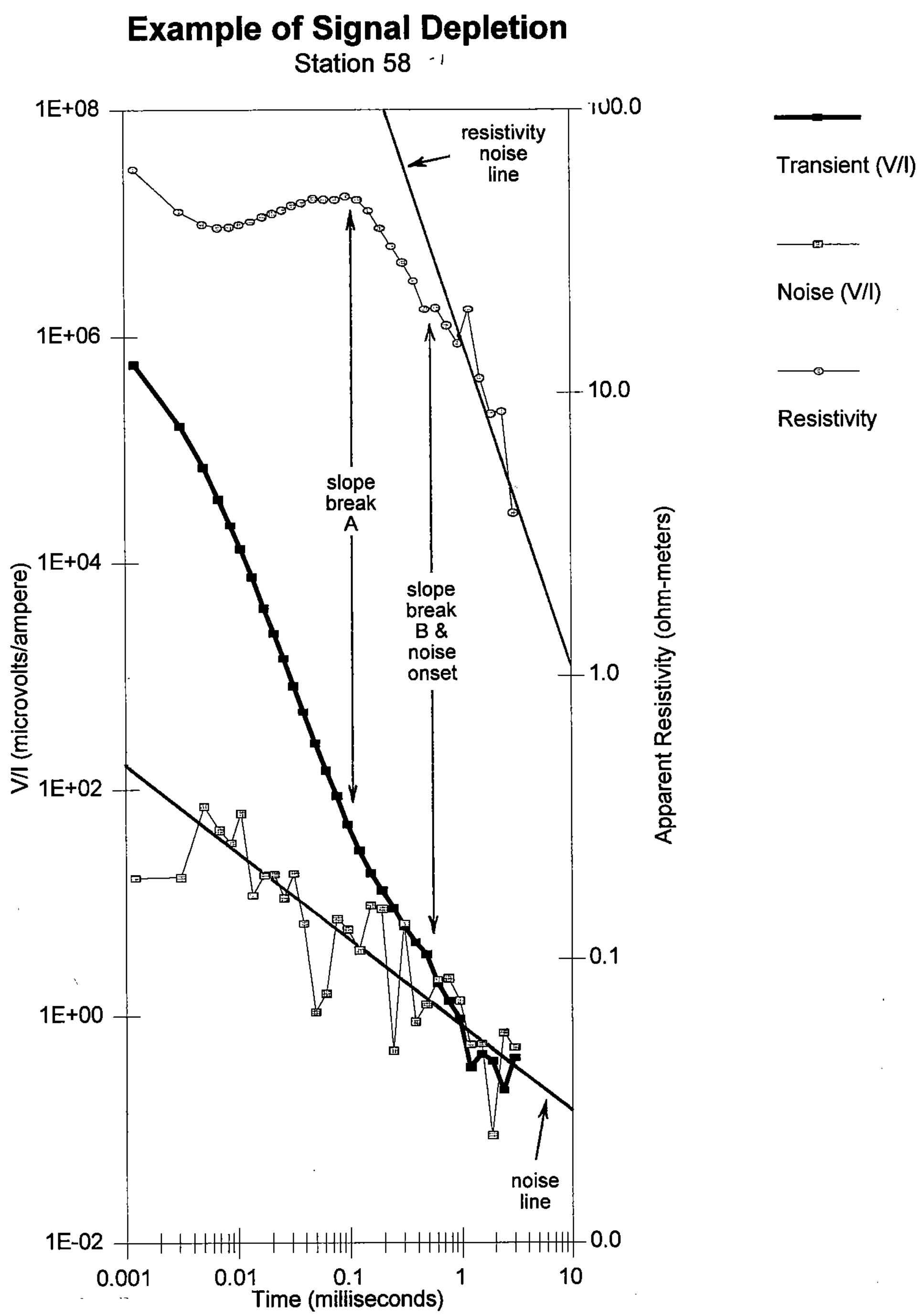
Test 6: Does the model roughly correlate with resistivity logs from nearby boreholes?

A semi-quantitative culture factor (identified as "Q" in this report) can be devised to assist the interpretation. This process may include some or all of the tests above. An example is shown in Section G.3.3.

G.1.7 Signal Depletion Effects

How Signal and Noise Interact in Late Time — As the electromagnetic smoke ring moves down into the ground, its signal strength dissipates rapidly, while electromagnetic noise persists. At some time during the signal decay, noise will begin to dominate the feeble signal. Figure G-7 shows how the decaying signal and ambient field noise can influence the measured field data. The

Figure G-7


Example of Signal Depletion
Station 58
1E+08
1E+06
1E+04
1E+02
1E+00
1E-02
V/I (microvolts/ampere)
100.0
10.0
1.0
0.1
0.0
Apparent Resistivity (ohm-meters)
0.001
0.01
0.1
1
10
Time (milliseconds)
resistivity noise line
slope break A
slope break B & noise onset
noise line
Transient (V/I)
Noise (V/I)
Resistivity

This page intentionally left blank.

data come from station 58, where transient measurements were taken with a 3-ampere transmitted signal, and noise measured with the signal turned off. Noise data have negative voltage spikes inverted to positive to aid this presentation. The plot shows normalized voltage data (lower curves) referenced to the left-hand scale, and resistivity data (top curve) referenced to the right-hand scale.

Looking first at the noise (gray boxes in Figure G-7), notice the clear decrease in noise amplitude with increasing time, demonstrating the higher frequency character of electrical noise. The noise is "noisy" — lengthy stacking and averaging in the field would be required to smooth the response. However, the noise is nicely fitted by the "noise line" regression ($y=0.813x^{-0.759}$; $r=-0.87$). The noise response is similar to those in published examples (Munkholm & Auken, 1996).

The transient curve (darkest line) shows a typical early-time response, then steepens as it enters the late time regime. Near an elapsed time of 0.1 millisecond, the transient changes to a shallower slope (labeled "slope break A" in the plot), attributed to a geologic layer. At later times, the transient voltage weakens to about the same voltage of the ambient noise, and two problems arise. First, since the sounding is a sum of transient voltage and noise, and since the signal-to-noise ratio deteriorates with time, the sounding no longer declines steeply as predicted by the mathematics, but becomes asymptotic to the noise line. Second, the data become noisy, and the sounding curve begins to bobble up and down from its asymptotic decline along the noise line. Both of these symptoms occur at the point labeled "slope break B" in Figure G-7. This is the point of signal depletion.

One can approximate the time window at which signal becomes depleted by considering the dynamic range of the receiver. Modern instruments measure signals not as a voltage, but as a digitized voltage, breaking the signal up into digital "bits." For example, the 16-bit receiver used for this work breaks the incoming signal into 16 parts, using 15 bits to resolve the signal and the

16^{th} bit to determine positive or negative sign. Thus an input signal would be divided into $2^{15} = 32,768$ parts. The system would run out of resolution when the signal strength drops below 1 bit of accuracy, or $2^{15} = 10^{4.5} = 4.5$ decades. Knowing this, one can look at a decay curve and estimate the point of signal depletion.

Problems Late-Time Noise Can Cause — The artificial change in the transient curve at slope break B causes an artificial change in the resistivity response, as shown at the top of Figure G-7. At this point, resistivity becomes asymptotic to the resistivity noise line (the transformed image of the voltage noise line) and noise increases. A one-dimensional model, which does not incorporate noise effects, would incorrectly show a strong conductor at slope break B.

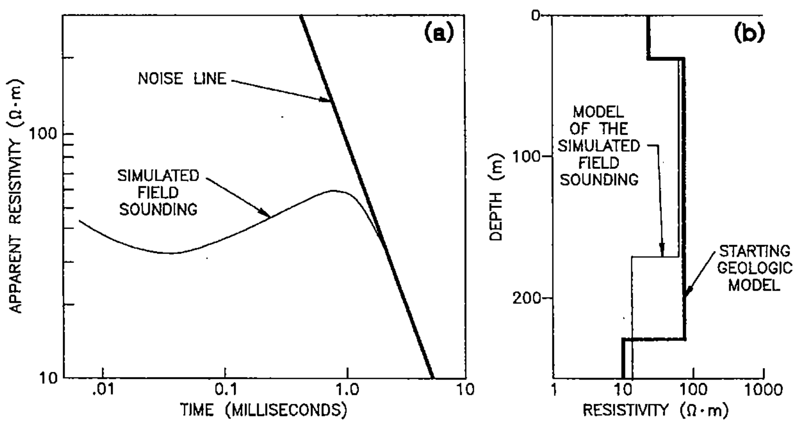
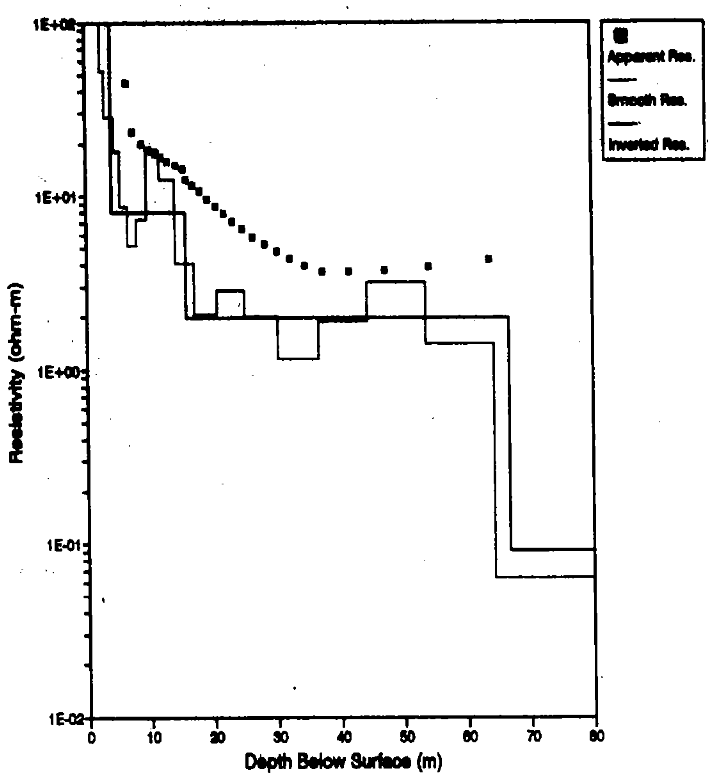


Figure G-8. *Effect of noise on synthetic data, from Munkholm & Auken (1996).*

An example of the effects of noise on synthetic modeled data is presented by Munkholm & Auken (1996). A one-dimensional forward model was used to calculate the response to a three-layer resistivity structure, and a Gaussian noise model was used to calculate the response of pure noise. The sum of the model response and the noise response simulates a field sounding. Figure G-8 shows the result when the simulated sounding is modeled; the predicted Layer 3 interface depth is picked too shallowly.

The signal-depletion problem may be more widespread than presently recognized. Although Spies and Frischknecht (1991) and others have discussed some aspects of the problem, late-time

Figure G-9
Three Representations of Subsurface Resistivity



peculiarities are routinely attributed to three-dimensional conductors located away from the loop. As an example, Goldman et al., (1994) and Newman et al., (1987) have noted a steep resistivity increase and, in some cases, a sharp decrease in late-time TEM data, which cannot be reproduced with one-dimensional models, but can be explained as three-dimensional conductive bodies at depth. This is certainly possible, but nearly every TEM data set one might encounter, regardless of geographic location, shows a late-time drop in resistivity. Hence one cannot conclude that all such effects observed in the field are from deep conductors. Instead, signal depletion must be suspected until demonstrated otherwise.

Tests for Signal Depletion — Given the possibility of interpreting a non-existent conductive layer, or of incorrectly estimating the depth of a real layer, how can signal depletion be recognized in a data set? Six tests have been devised:

Test 1: Examine the complete set of soundings as a whole to see if a certain slope break is related to signal depletion, geology, or both. Equation G-2 can be written (Spies and Frischknecht, 1991) to show that the time of signal depletion t_{max} is:

$$t_{\max} = 1.9x10^{-7}(IA)^{2/5}\rho_o^{-3/5}\eta_\upsilon^{2/5} , \tag{G-5}$$

where ρ_o is the resistivity of the overlying material (assumed to be homogeneous). It is theoretically possible to calculate t_{max} for each station, but η_υ is not precisely known for the exact amount and character of field noise. Instead, it is more convenient to lump the constants I, A, and η_υ together as a single constant K, producing a simple relationship $t_{max} = K\rho_o^{-3/5}$. By plotting the times of the first slope break versus the resistivity at that break for each TEM sounding, one can test the data for signal depletion effects. Stations with cultural effects or unusual noise are excluded. If the data fit the $t_{max} = K\rho_o^{-3/5}$ line without scatter, modeling results at the slope break should not be attributed to geology. If considerable scatter results, or if there is no correlation with the expected noise response, at least some soundings may be considered further for geologic mapping. This is not a test of any single station but merely an overview of the data set as a whole.

Test 2: Determine if the slope break corresponds to an onset of noise. If it does, the break may be caused by signal depletion, and the model results at this depth should be rejected. If the slope break and the noise onset are separated by half a decade of time or more, it can be reasonably assumed that a signal-to-noise ratio of at least 5:1 exists, and that the stacked-and-averaged sounding curve would be dominated by transient signals due to geology.

Test 3: Can the model fit the data at the slope break? If not, the data should be examined skeptically. Since three-dimensional resistivity features can't be modeled by a 1D model, such a misfit could also be an artifact of geology.

Test 4: Does the model give a realistic resistivity for the conductor modeled at the slope break? If it does not, and no other explanations are forthcoming (e.g., off-line cultural effects), the model should be examined skeptically. A "realistic" resistivity would be a change of approximately one to two orders of magnitude from layer to layer, or values not below 0.1 ohm-meter.

Test 5: Does the model roughly correlate with resistivity logs from nearby boreholes?

Test 6: Measure transient and ambient noise separately. This is useful, but rarely done due to excessive field time required to obtain usable noise data.

As an illustration, reconsider the example of station 58. Imposing Test 2, slope break A is well separated from the onset of noise, suggesting it is due to geology. Tests 3 and 4 show that slope break A is represented by a realistic model, but break B cannot be modeled, even for an (unrealistic) infinitely conducting lower layer; this suggests slope break A is not a signal depletion effect, and therefore of geologic origin. Test 5, by comparing the sounding to borehole resistivities from U-98, shows that the conductor modeled at slope break A corresponds to the Cook Mountain Formation, and the resistivity structures of the model resemble those in the log. In Test 6, the sounding approaches the noise line at slope break B, not A. Based on these tests, slope break A at station 58 is interpreted as a real geologic feature.

This page intentionally left blank.

G.2 HOW TEM WAS USED ON THIS PROJECT

SECTION G.2 SUMMARY

This section describes how the TEM equipment was operated and the steps used to model and interpret the data. It contains useful background information for the geologic interpretation (Section G.4).

This project used a central loop TEM array, which transmits current with a square wire loop and receives the signal with an interior, smaller wire loop. A digital receiver was used to filter and stack many signals to reduce extraneous noise.

Once the data are edited and processed, they can be modeled. There are two ways to do this, but the *inversion model* is the most useful technique for this particular application. The modeling process finds a sequence of layers, each with differing resistivities and thicknesses, which would cause the observed signal response. The best model is the one with the fewest layers which "fit the data" successfully.

At most TEM stations, four to five layers were needed to fit the data. Layer 1 (the surface layer) was resistive, and was often underlain by a thin layer, known as the "loess conductor." Deeper layers decreased successively in their resistivities. All these layers are merely electrical structure, which may or may not have geological significance. To convert the models to more useful geologic information, they must be "calibrated" at control points where geology is well known. This process is described in Section G.4.

G.2.1 How the Equipment was Set Up

A small, in-loop TEM array was chosen for this study because it is best adapted to crowded industrial sites, it has good resolution, its rejection of culture is better than other arrays, and it is more simply interpreted. The array consisted of a single-turn 20x20-m square loop to generate the signal and a 5x5-m square loop to detect the magnetic field derivative as an induced voltage. The 16-bit Zonge Engineering "NanoTEM" system used for field work employs a battery-powered transmitter to generate a repetitive time-domain pulse at a frequency of 32 Hz. In the configuration used, the transmitter shutoff was approximately 1.5 microseconds (μs). Data were acquired in 31 time windows along the transient decay curve. The first window center is at

1.22 μs, and subsequent windows are at integral multiples (2x, 3x, 4x, etc.), of Window 1. The last window is at 3020 μs. Voltages were measured with a multi-channel receiver and stored in memory.

The field instrument calibrated itself prior to every data collection event, compensating for drift in analog components. Setup parameters were systematically checked at each sounding, and data were plotted in the field to ensure that the voltage and resistivity measurements conformed to the expected range of numbers at the site.

The instrumentation displayed decay curves and Bostick-inverted resistivity curves (Bostick, 1977) with error bars in the field, allowing continual monitoring of data quality. Displays of real-time data scatter during acquisition allowed the operator to optimize stacking time for the project objectives. Typically about 2,000 decay cycles (each representing a single decay curve) were stacked and averaged to produce a "stack burst." At least two complete stack bursts were obtained at every station to quantify the data scatter. Typical acquisition time to produce clean data was a few minutes; it took 10 to 30 minutes to move the system and set up on the next station.

Data were plotted in plan view during field work, and decay curves were noted in a field notebook to provide a readily available record of various types of decay patterns.

The field work was done in three events. The NAS Memphis Northside was investigated April 4 and 6 and May 2 to 5, 1994. The Southside was investigated August 2 to 16 1995; additional measurements were obtained at that time on the Northside. A base station was occupied repeatedly to compare the three episodes of work. Most of the 215 soundings obtained were at random points on the property, but some were adjacent pairs. All station positions were surveyed with global positioning system (GPS) equipment to facilitate modeling and plotting.

G.2.2 Data Processing and Interpretation

Editing and Modeling — Following field acquisition, the raw data files were edited to correct field errors and to separate production data from system tests. Sequential stack bursts were averaged for each station, resulting in a stacked and averaged voltage decay curve and error estimates for each station.

The voltage decay curves were converted to resistivity values for evaluation of subsurface structure. Three types of resistivity representations were examined: the raw apparent resistivity curves, imaged resistivity, and inverted resistivity. Figure G-9 illustrates these three parameters.

Apparent resistivity was plotted as a function of time window or against depths estimated from equation G-3. The term *apparent* resistivity is used because any individual data point on the sounding curve does not correspond to a discrete resistivity value for material at its calculated depth, but rather is a complex response to the entire section of material overlying it. In effect, it is a first guess of the subsurface resistivity structure.

Imaging is the attempt to convert apparent resistivity to a truer representation of the resistivity values associated with specific depths. This conversion is accomplished by assuming many thin layers and iteratively varying their resistivities to reproduce the decay curve. The resistivity transitions from one thin layer to the next are constrained to be smoothly varying, giving rise to the term *smooth modeling*. The result is a gradational, "fuzzy" image of resistivity structure, without sudden, distinct electrical breaks. This type of image is appropriate for the inherently fuzzy resolution of an electromagnetic sounding, but the results are less than satisfying because the models yield no firm depth to various subsurface layers and features.

The most useful information for geologic mapping is a *resistivity inversion model*. The inversion process finds a one-dimensional set of layers which reproduces the measured decay curve (two- and three-dimensional TEM algorithms are not yet available in practical application). Unlike

This page intentionally left blank.

This page intentionally left blank.

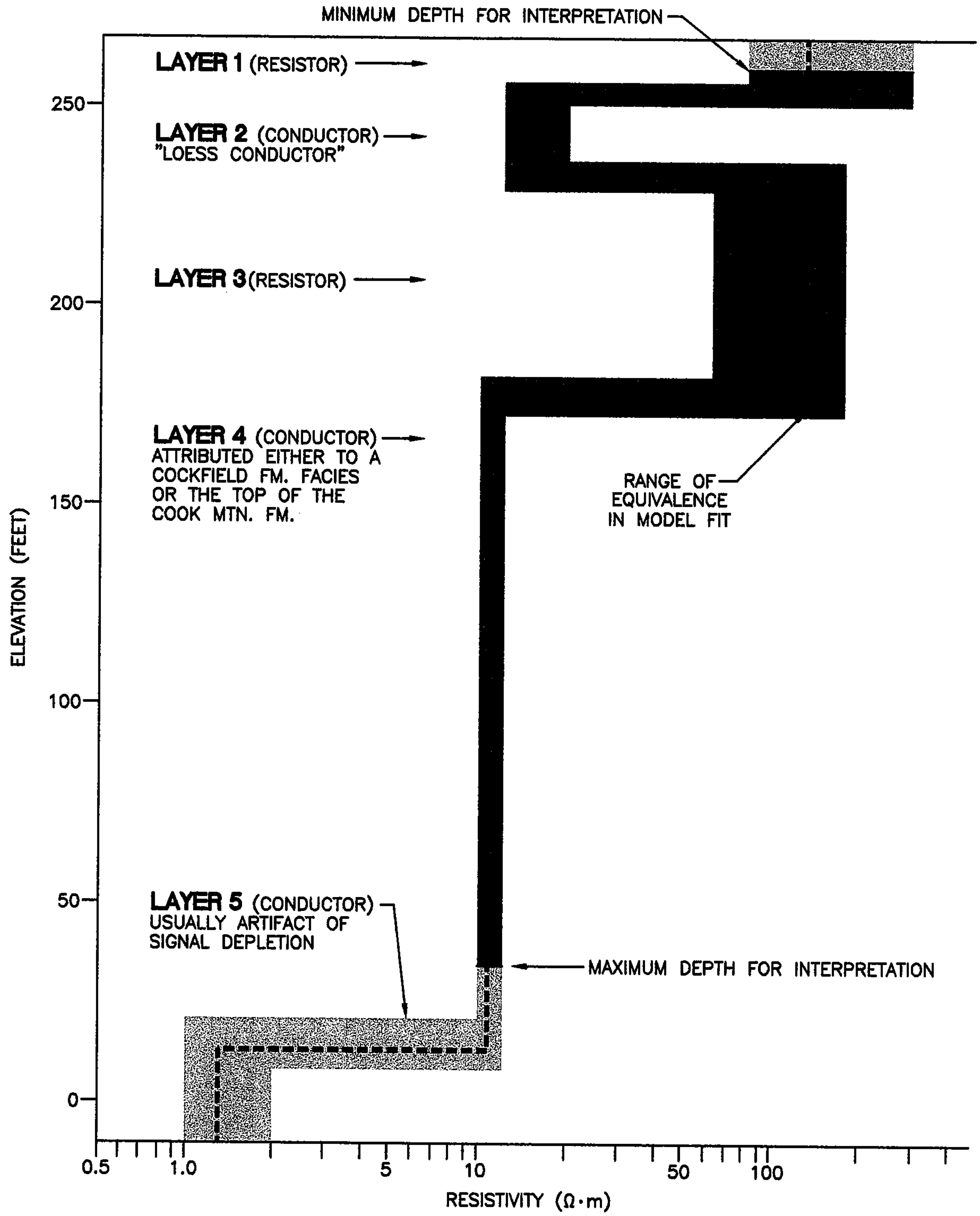
the smooth model, inversion parameters are not required to be smoothly varying, and only a minimum number of layers are used to represent the resistivity curve. Inversions are used almost exclusively in this report. Data consist of resistivity and thickness of each layer, accompanied by a *range of equivalence* for each parameter. The range of equivalence is a calculation of how much each parameter can be perturbed without destabilizing the model's fit to the data, and thus assesses the degree of confidence in the modeled values.

Inversions used a ridge regression algorithm (Inman, 1975). This one-dimensional model assumes a sequence of layers extending infinitely in all directions (the model breaks down for strongly localized conductors). The modeling process starts by looking at the sounding curve and estimating how many layers are needed to reproduce it. Since electrical responses do not always correspond to mapped geologic units, it was decided to not force the models to agree with geology in the modeling phase of this project. Instead, the focus was to find a best fit to the field responses. After modeling was completed, the results were integrated with the geology and jointly interpreted.

Three to six layers were needed to fit the TEM data. Although it is possible to fit the data with more layers, a many-layered depiction would imply more resolution than TEM offers. Instead, a minimalist approach was taken, using the fewest layers needed to adequately fit the data. Range of equivalence data were used to test the statistical significance of each layer. Within this constraint, the input model was kept consistent from one station to the next unless the data required a change in model type.

Figure G-10 shows a typical TEM model. Layer 1 was consistently resistive across the site, but its resistivity is poorly determined because it depends on the first one or two time windows. Below this was Layer 2, a thin conductor dubbed the "loess conductor" because it usually falls in the middle to lower part of the loess. This layer was required to fit many of the soundings, where

This page intentionally left blank.



RCRA FACILITY INVESTIGATION
NAVAL SUPPORT ACTIVITY
MID–SOUTH
MILLINGTON, TN

FIGURE G–10
TYPICAL TEM MODEL
(STATION 22)

DWG DATE: 02/03/00	DWG NAME: 0094G017

This page intentionally left blank.

In other cases a model with a sequence of decreasing resistivities with depth was also successful. In such cases, the sequential model was retained because it represented the simplest explanation of the data. Layer 3 was relatively resistive and often included parts of the fluvial deposits and the upper part of the Cockfield Formation. Layer 4, which was usually strongly conductive, was attributed to different geologic units, depending on the area: in some places, it appeared to be caused by a conductive subunit within the Cockfield Formation (rarely the formation's top). In other areas, it appears to mark the top of the Cook Mountain Formation. Distinguishing which of these units cause the layer is easier at "calibration points" near logged boreholes, and becomes progressively less certain away from them. Occasionally, Layer 4, and almost always Layers 5 to 6, were attributed to culture or signal-depletion effects.

The gray areas in Figure G-10 illustrate the ranges of equivalence of the model. Although the dark black line represents the best solution, the range of equivalence bounds suggest how much the layer resistivities and depths can be perturbed without seriously destabilizing the solution. Range of equivalence plots were also used to judge the statistical distinctiveness of each layer; if adjacent layers had overlapping ranges of equivalence, they were combined to make the simplest fit. Note that the range of equivalence is larger for resistors than conductors, and it tends to increase for deeper layers.

Once modeled, the data were examined for cultural and signal-depletion effects, as described in Section G.3. Model layers considered to be affected by these phenomena were rejected from the final interpretive database. The minimum and maximum interpreted depths at station 22 are illustrated in the example of Figure G-10.

Tying Models to Geologic Formations — Modeled layers were interpreted for geologic structure by "calibrating" them against existing borehole control, in a process similar to that used for downhole log correlations. At each control point, a plot was constructed showing the TEM layers, the downhole resistivity log, and the geologic contact picks. Plan-view plots were also made to analyze the strength and spatial consistency of downhole resistivity contrasts at the Cockfield and Cook Mountain Formations. Assuming sufficient contrasts existed, TEM layers were then assigned to a specific geologic unit at the control points. These were then reviewed to minimize inconsistencies, and to ensure that the general character of the TEM model matched the log response. The data were reviewed for the degree of statistical correlation with geologic picks (the results are in Section G.3).

Once the calibration process was complete, a large set of TEM-geologic cross-sections were constructed. Using an interpolative process, layers at other TEM stations were assigned to a formation as appropriate, starting near the control points and moving progressively farther. The process was complicated by the fact that a specific TEM layer did not always correspond to a specific formational contact. For example, in one area, the top of the Cook Mountain Formation might correspond to Layer 4, but in another area it might correspond to Layer 3, depending on the presence or absence of interpreted resistivity facies in overlying units. The TEM picks were continually tested for unusual discontinuities in which a layer was assigned to a certain formational contact. As one might expect, the process yielded the largest uncertainties farthest from the control points, especially where extrapolation rather than interpolation was required. The uncertainties were large enough at many stations to prevent a formation pick.

The next step was to construct plan-view maps of formation surfaces, using both TEM and geologic picks as an integrated data set. Borehole data are the most reliable, but are widely scattered; TEM data are less reliable, but have a much better spatial data density. The combined data set uses the strengths from each technique.

G.3 DATA QUALITY ANALYSIS

SECTION G.3 SUMMARY

This section looks at the inherent errors in the TEM models and examines the degree to which those errors limit the geologic interpretation. If your interest is only what the final interpretation is, skip to Section G.4. If you want to critically examine how the errors were dealt with and how they might validate or invalidate the final conclusions, read Sections G.1 and G.2, then this one.

The presence of culture, particularly metal pipes, distorts some of the data. Building on tests outlined in Section G.1, cultural problems were quantified at each station, and the most affected stations were eliminated from the final data set. This reduces, but does not eliminate, unwanted influences from culture.

Signal depletion effects were analyzed according to principles and tests outlined in Section G.1. The problem occurs in the deeper modeled layers. At each station, the layer at which the problem occurs, and all layers below it, were eliminated from the data set.

With these two major issues resolved, attention is focused on defining how well the data can be repeated. Multiple repeats at a base station and repeats at closely adjacent TEM stations show that modeled resistivities are reasonably repeatable, for conductive formations. More importantly, the tops of the deeper conductive units have an estimated error of ±18 feet when analyzed in this way. Resistive units are either not detected or have large errors in estimating their depths.

However, the more important question is how well the TEM data can map the geology. After the data near borehole control were "calibrated" against resistivity logs from those boreholes, TEM layers were assigned geologic significance. The analyzed results show that the top of the Cockfield Formation is mapped only 7% of the time because of its indistinct electrical signature, although conductive facies in the Cockfield are observed more frequently. The Cook Mountain is detected 50% of the time, and the mean error in picking its correct top elevation is ±19.5 feet. The TEM picks appear to be biased too low by -13 feet. These two figures provide a good test of TEM's ability to map Cook Mountain structure — a test applied in Section G.4.

G.3.1 Cultural Bias

TEM stations were located to avoid culture, but the density of underground lines made it impossible to completely avoid cultural influences in some areas, particularly in the industrialized center of the study area. Some stations show obvious culture, with noisy data in the mid-time part of the curves, or with strongly elevated transients in late time. Figure G-4 illustrates these effects. Excessively disrupted (but repeatable) data were encountered in a well-defined zone on the northwest part of the study area, in open plowed fields where no culture is indicated on the facility maps. Interviews with maintenance officers of the nearby communications network, which roughly encloses the problem area, indicated that the network uses megaHertz-range frequencies — far above the TEM frequency range. A beat frequency between two signals with slightly different frequencies might have caused the trouble; at present, the noise source is unexplained.

Data at all stations were subjected to the tests outlined in Section G.1.6 and G.1.7. Three categories were considered, in order of priority: (1) proximity to potentially biasing culture, especially buried metal lines; (2) bumpiness or excessive noise in the early- to mid-time data; (3) radical departures of curve character from that of curves from nearby stations, with particular attention to anomalously long transients, accompanied by noise suppression. Consistency checks were made in plan view and cross-section plots. A numerical evaluation (1 = no problem, 5 = severest problem) was assigned to each of the three categories, and a weighted average was obtained. This is the cultural evaluation "Q" figure mentioned in this report.

Most stations with Q values exceeding 4.5 were summarily eliminated from the database. For the remaining stations, modeled layers were rejected as appropriate to the specific observed problems in the data. For example, at a station with an anomalously elevated transient, a conductive layer arising from that transient was eliminated, as well as all deeper layers. Similarly, a station with mid-time bumpiness attributed to culture had all layers at and below the depth corresponding to the bumps removed from the database. Usually deeper layers were interpreted only at stations with Q values less than 2; the higher the Q value, the fewer layers interpreted. Thus, picks of the top of the Cook Mountain Formation, which were assigned to one of the deeper layers, were made only at stations apparently free of significant cultural effects.

This process effectively established a maximum sounding depth based on cultural effects alone. A similar determination was obtained from an independent analysis of signal-depletion effects. The shallowest of these two values was used as the cutoff elevation, below which the modeled parameters were deemed sufficiently questionable to not be used in the interpretation.

G.3.2 Signal Depletion Effects

Equation G-5 suggests that the degree to which resistivity correlated to slope break time would indicate the relative influences of geology versus noise on the data set as a whole. The data at NSA Mid-South were analyzed for times of slope breaks A and B. Only stations with cultural "Q" factors of less than 3.0 were considered; those without obvious slope breaks were omitted. Slope break A was picked at the inflection point on the resistivity curve; break B was picked at the average of the times of the second inflection point and the onset of noise (the latter judged visually by examining error bars on decay plots).

Several difficulties arise in comparing these times to resistivity. First, resistivity is not constant as a function of depth. Which layer's resistivity best represents the resistivity of equation G-5? Second, resistivities of the more resistive layers are very unstable, a characteristic of electromagnetic methods; this leads to excessive data scatter on the resistive end of the plot. Third, plots from different sites cannot be compared because differing resistivity structures from site to site cause a strong shift along the resistivity axis for each individual site.

Unpublished EnSafe research suggests that a better choice is the bulk conductance of all layers overlying the slope break. This parameter is a measure of the net electrical effect of the overlying layers on the TEM response, and is calculated as the sum of the conductances of the overlying layers. It is robust and solves all three problems associated with using resistivity as a correlation parameter. The bulk conductance can be converted to a net bulk resistivity by dividing the depth to the layer causing the slope break by the bulk conductance of all layers above it.

Figure G-11 shows slope break data from three TEM projects plotted against bulk resistivity. The plot includes only stations where the break was well defined and which are thought to be free of cultural effects (44 stations). The larger boxes represent NSA Mid-South data; smaller boxes are from TEM data obtained at sites in Ohio and Kentucky (Hughes, 1995). The line fits all slope break B data ($\rho=5.53t^{-0.52}$, 201 points, r=-0.52). The fit quality is poor due to considerable scatter in the data, and the slope differs from the theoretical $\rho=Kt^{-1.7}$. The fit is worse for the NSA Mid-South slope B data alone ($\rho=6.51t^{-3.50}$, 82 points, r=-0.37); the data are almost uncorrelated and the slope is wrong. Slope break A data, not attributed to signal depletion, show an expected poor correlation ($\rho=19.1t^{-2.14}$, 85 points, r=-0.37).

The results suggest that slope break A is mostly related to geology, but slope break B is partly controlled by signal depletion and partly by geology. Noise, consisting primarily of modeling errors and slightly mis-picked slope break times, probably influences the results to some degree, but does not fully explain the observed degree of scatter in Figure G-11. Instead, it is thought that even at slope break B, NSA Mid-South data are still affected by subsurface electrical contacts. Since it is not possible at this time to separate geologic effects from signal depletion and noise, modeled layers resulting from this slope break must be ignored. But based on these data, layers above this point, including slope break A, are considered to be useful for geologic mapping.

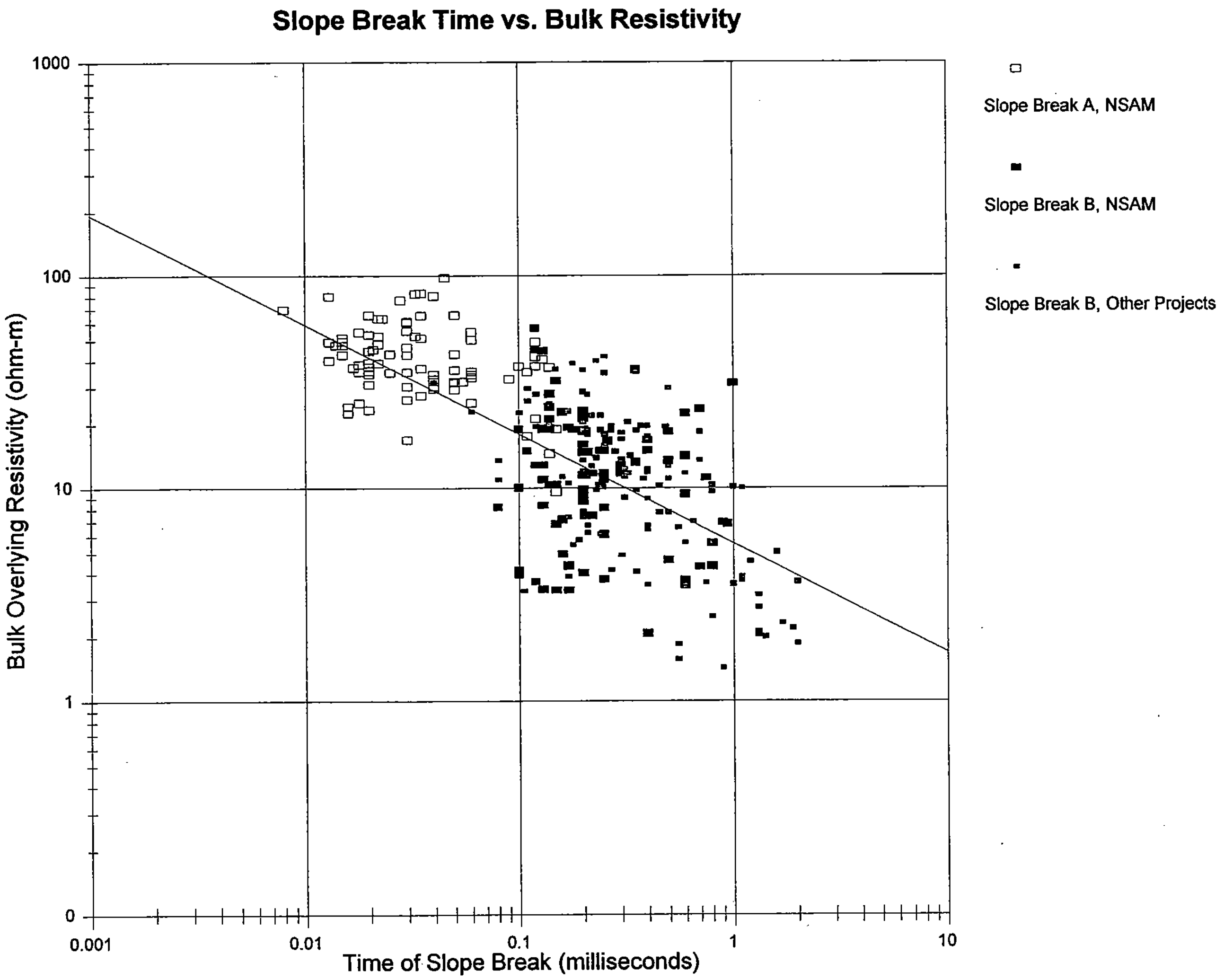


Figure G-11. Correlation of slope break times versus bulk resistivity

Therefore, for purposes of this report, data above slope break B have been interpreted as showing real geologic changes.

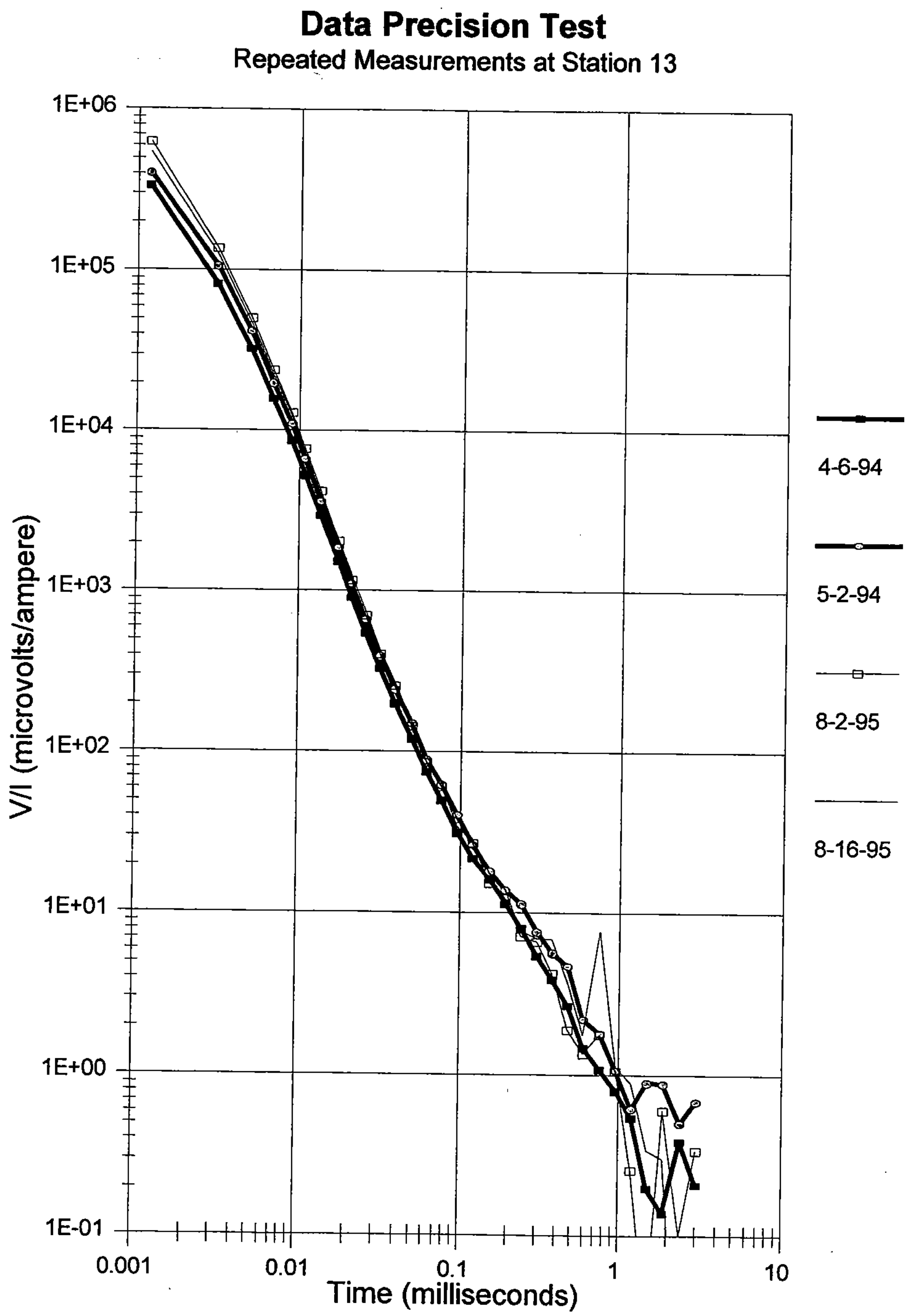
Assuming that slope break A (when present) is primarily influenced by geology, and break B is caused by noise, the effective maximum penetration depth must lie closer to break B. A strategy was devised to establish the maximum effective depth of each sounding, using the shallowest elevation of any one of the following four criteria: (1) one or two windows before slope break B; (2) above the onset of noise, judged by the $\pm 10\%$ criterion; (3) layer resistivity greater than 0.1 Ω·m; (4) curve irregularities or noise not jeopardizing model stability; (5) model yielding acceptable ranges of equivalence in depth and resistivity parameters. The results from this process were compared to those from the analysis of cultural effects, and the shallowest of these two values was used as the cutoff elevation. Below this the modeled parameters were deemed sufficiently questionable to not be used in the interpretation.

G.3.3 Data Repeatability (Precision)

Repeatability over Time — Data repeatability can be compromised by changes in ground moisture, variations in antenna setup, and a variety of equipment-related effects. To determine how temporal changes affect TEM repeatability, measurements were made at TEM station 13 on four dates during the 16-month span of the survey. Care was taken to position and orient the loops and instrumentation identically each time.

Figure G-12 shows the decay curves. Early-time responses vary, possibly because of varying surface soil moisture in this low-lying area. Mid-time responses are similar, but not identical, showing offsets related to the early-time differences. Late-time responses at times exceeding 0.3 milliseconds are the result of noise.

Figure G-12


Data Precision Test
Repeated Measurements at Station 13
1E+06
1E+05
1E+04
1E+03
1E+02
1E+01
1E+00
1E-01
V/I (microvolts/ampere)
0.001
0.01
0.1
1
10
Time (milliseconds)
4-6-94
5-2-94
8-2-95
8-16-95

This page intentionally left blank.

Data for the four repeat events were modeled separately, using a common starting model and allowing the algorithm to seek a best fit, with all parameters unconstrained. Table G-1 shows the results. Resistivities show typical uncertainties for TEM, with the resistivities of shallower conductive layers the best determined. Depth determinations become increasingly uncertain with depth below the surface; all are determined to better than ±14.5% of the depth of burial, and therefore reasonable with respect to the ±15% rule of thumb (Section G.1). Of particular note is layer 4 (indicated in bold), which, as described later, is interpreted to be the Cook Mountain Formation at this station. Models of this formation's top show a scatter of ±3.2 meters, or ±10.5 feet (corresponding to ±7% of the depth of burial).

Repeatability at Adjacent TEM Stations — The relatively small size of the TEM loops suggests that spatial aliasing should be minimal at adjacent soundings. Thus, in the absence of culture, adjacent soundings serve as a check on local-scale repeatability. Data were obtained at 44 station pairs as part of this project. Most of the pairs show similar responses, with a few significant exceptions.

Table G-1
TEM Repeatability at Station 13 (Modeling Results)

Layer	**6 Apr 1994** *Solution & Range of Equivalence*	**2 May 1994** *Solution & Range of Equivalence*	**2 Aug 1995** *Solution & Range of Equivalence*	**16 Aug 1995** *Solution & Range of Equivalence*	**Average**
LAYER RESISTIVITIES ρ_n (ohm-meters)					
ρ_1	247 (133-645)	168 (123-314)	107 (57-378)	90 (62-137)	153±71
ρ_2	27 (15-40)	23 (15-35)	18 (7-44)	28 (12-43)	24±5
ρ_3	94 (74-126)	92 (71-119)	94 (56-173)	78 (59-102)	90±8
ρ_4	**7.5 (3.6-15)**	**3.8 (2.0-7.1)**	**4.9 (1.6-15)**	**5.5 (3.2-9.4)**	**5.4±1.6**
ρ_5	1.0 (0.5-1.9)	0.22 (0.09-0.54)	0.39 (0.07-2.2)	0.57 (0.27-1.9)	0.55±0.34
(ρ_6)	0.06 (0.01-0.23)	0.02 (0.00-0.11)	0.013 (0.00-0.13)	0.01 (0.01-0.13)	0.03±0.02

Table G-1
TEM Repeatability at Station 13 (Modeling Results)

Layer	**6 Apr 1994** *Solution & Range of Equivalence*	**2 May 1994** *Solution & Range of Equivalence*	**2 Aug 1995** *Solution & Range of Equivalence*	**16 Aug 1995** *Solution & Range of Equivalence*	Average
LAYER ELEVATIONS E_n (meters)					
E_2	77.3 (75.3-78.9)	77.3 (75.3-78.9)	78.4 (73.5-82.4)	78.4 (75.2-80.5)	77.9±0.6
E_3	72.8 (68.7-76.7)	72.7 (68.4-76.6)	75.5 (66.7-81.7)	74.2 (65.9-78.6)	73.8±1.3
E_4	**37.6 (35.9-46.9)**	**44.7 (34.4-53.7)**	**38.5 (19.5-52.7)**	**38.9 (22.2-50.0)**	**39.9±3.2**
E_5	20.6 (15.4-33.8)	32.4 (18.7-44.1)	20.8 (-9.0 to 41.7)	20.8 (-0.6 to 35.6)	23.7±5.8
(E_6)	2.6 (-8.5 to 20.5)	24.4 (6.6-39.0)	8.2 (-41.9 to 36.9)	0.3 (-40.7 to 23.2)	8.9±10.9

Note:
Bold numbers (layer 4) indicate the interpreted Cook Mountain Formation.

Because the most important unit to be mapped in this study is the Cook Mountain Formation, poor repeatability has the greatest impact when determining the top of that unit. Data for all TEM station pairs in which at least one of the two soundings were interpreted for this contact are shown in Table G-2. The repeats for these pairs are well within the 15%-of-depth rule of thumb, but pair-average elevations have standard deviations of up to 25 feet. An estimate of repeatability or precision can be obtained by averaging these standard deviations, obtaining the standard deviation of the average, and summing the two. This gives an adjacent-pair repeatability of ±17.7 feet for the elevation of the top of the Cook Mountain Formation. This suggests that TEM model variations of less than ±18 feet in the elevation of this contact are statistically insignificant.

Table G-2
Repeatability in Models of the Cook Mountain Top at Adjacent TEM Soundings

Stations	Elevation of Top of Cook Mountain (feet)	Elevation Average and Standard Deviation (feet)	Standard Deviation as a % of Depth
22, 23	178.1, 183.4	180.8±3.7	±4%
50, 51	98.4, 110.23	104.3±8.4	±4%

Table G-2
Repeatability in Models of the Cook Mountain Top at Adjacent TEM Soundings

Stations	Elevation of Top of Cook Mountain (feet)	Elevation Average and Standard Deviation (feet)	Standard Deviation as a % of Depth
120, 121	100.4, ND*	—	—
145, 146	136.5, 121.4	128.9±10.7	±8%
146, 147	121.4, 126.6	124.0±3.7	±2%
147, 148	126.6, 135.5	131.1±6.3	±5%
175, 176	109.3, 79.7	94.5±20.9	±12%
176, 903	79.7, 92.8	86.3±9.3	±5%
192, 193	69.9, 104.7	87.3±24.6	±13%
207, 208	92.8, 88.9	90.9±2.8	±1%

Note:
ND* = No pick due to signal depletion problems in the data

G.3.4 How Well Did TEM Map the Geology?

To help translate TEM layers to useful geologic information, TEM data were obtained and "calibrated" at boreholes and wells for which long-normal resistivity logs are available. Such comparisons should be regarded as approximate for several reasons: (1) TEM has poorer vertical resolution than the downhole data; (2) TEM has greater side-looking ability than downhole data; (3) TEM is less effective in seeing resistive units positioned between conductive horizons; (4) TEM stations are not always right over the borings, but may be offset up to some 150 feet; (5) TEM resistivities can be biased low by effects of culture and signal depletion; and (6) downhole data are subject to variable effects of mud invasion, local conductive anomalies, and signal coupling in the borehole. As a result, only an approximate correlation of TEM and downhole data should be expected.

Figure G-13 compares log and TEM modeled data at all eight borings with substantial comparative data. Only TEM layers above the maximum depth cutoff are shown. Formation contacts are based on correlations of gamma logs by Carmichael et al., (1997); formation names are abbreviated. Well identifications are shortened forms of the USGS designations, which have an "Sh:" prefix for Shelby County (Carmichael et al., 1997). Downhole resistivity data are long-normal resistivities.

The data comparison can be broken down into three practical questions, detailed below:

How Reliable are TEM Resistivity Values? — In most cases, TEM-modeled resistivities are lower than downhole resistivities, especially in the deeper parts of the soundings. Mismatches range from a few ohm-meters to more than an order of magnitude. Figure G-14 shows a scatter plot of these two parameters, using all appropriate data from nine boreholes and their nearby TEM stations. Comparisons were made for discrete depth intervals at each borehole chosen to best represent major resistivity breaks in the TEM or log data. Symbols differentiate data by formation and according to whether the models included a loess conductor ("LC") or not ("no LC").

The full data set shows a good deal of scatter, attributed to the factors mentioned above. A power-curve fit shows only a fair correlation coefficient ($r=0.69$) and a fit (dashed line in Figure G-14) slightly askew from the theoretical line. Note that the largest deviations from the theoretical line often occur where no loess conductor is modeled (open symbols). Data with a loess conductor modeled (solid symbols) are better correlated ($r=0.79$) but the slope is askew in the other direction. The skewness is probably an artifact of scatter. In general, the data show an average bias in TEM resistivities of half a decade lower than the corresponding log resistivities.

While there may be some imprecision in the borehole data, the major part of the mismatch originates with the TEM data. The most probable cause is a modeling artifact arising from incorrect characterization of near-surface conductors. Models are responsive to conductances of the model layers. If a thin layer near the surface has a high conductance, the later parts of the

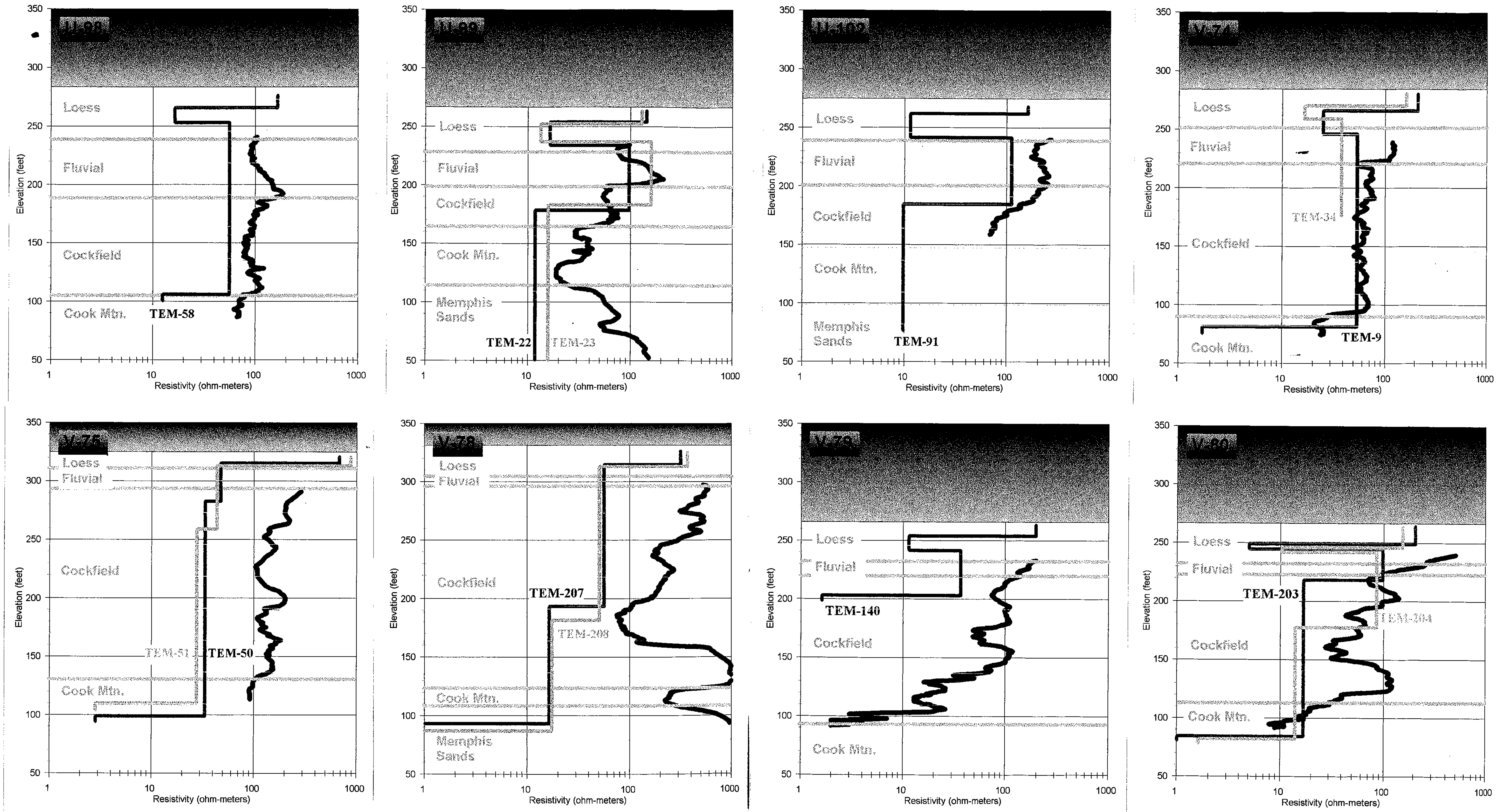
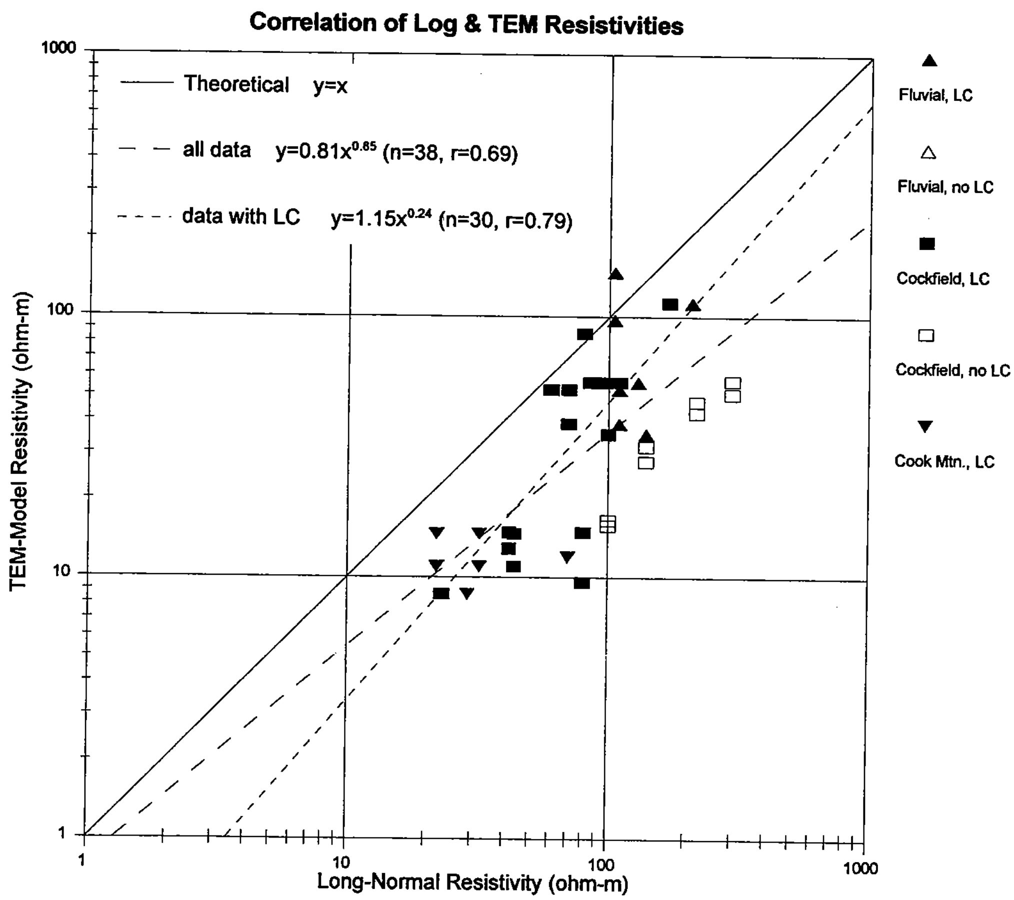


Fig. G-13. *Comparisons of downhole resistivity logs with models of nearby TEM stations.*

This page intentionally left blank.

Figure G-14


Correlation of Log & TEM Resistivities
Theoretical y=x
all data y=0.81x^0.85 (n=38, r=0.69)
data with LC y=1.15x^0.24 (n=30, r=0.79)
TEM-Model Resistivity (ohm-m)
Long-Normal Resistivity (ohm-m)
1000
100
10
1
1
10
100
1000
Fluvial, LC
Fluvial, no LC
Cockfield, LC
Cockfield, no LC
Cook Mtn., LC

curve are dragged down in resistivity, and to compensate, resistivities in the lower units are increased. If the near-surface layer is not modeled as a conductor, the resistivities of deeper units will be too high, and the model adjusts them lower. Note in Figure G-14 that when a loess conductor is modeled, resistivities tend to be higher than when it is not. But since not even the data with a loess conductor match the theoretical response, it is proposed that an unresolved, very near-surface conductor is not properly accounted for in the models. No data support this, other than the fact that frequency domain EM data show slightly lower surficial resistivities that the TEM models produce.

Two factors are worth noting. First, the absolute resistivities produced by the model are of secondary interest on this project, which seeks to map the tops of geologic units. Second, data can be interpreted for *relative* resistivity changes, bearing in mind the low bias with respect to true values. This suggests that subsurface electrical boundaries are detectable, regardless of absolute resistivity errors.

What Kinds of Electrical Features Can TEM See? — Figure G-13 illustrates some of the features that can and cannot be mapped. As expected, discrimination of resistive sections is poor. For example, the lower-fluvial resistor at U-98 and U-99 are undetected, as are most resistive facies in the Cockfield Formation. This behavior is most pronounced at V-78, where a strongly resistive facies in the lower Cockfield is not seen because TEM is more sensitive to the conductive change above it. Detection of conductors depends on the overall resistivity pattern. For example, where consistent resistivies are observed throughout a long vertical section (borings U-98, U-102, and V-74), TEM detects the resistivity drop at the Cook Mountain Formation and gives a relatively accurate depth to that unit. On the other hand, complex resistivity patterns confuse the TEM response, especially when resistivities decrease gradually with depth. In these cases, TEM may pick a layer at the average depth of the resistivity decrease (TEM 22 and 23), or between two conductive facies (TEM 204). Thus, in areas where the log shows a clear-cut conductor (as often occurs at the top of the Cook Mountain Formation), TEM is more likely to record that conductor.

Can TEM Map the Tops of Formations? — At this stage, the electrical layers modeled at TEM stations near logged boreholes were correlated with geologic contacts, using the procedure described in Section G.2.2. Picks of the Cockfield and Cook Mountain Formations for the two data sets are listed in Table G-3. The comparisons are grouped as follows: (1) borings at which resistivity logs showed a sufficiently clear formational resistivity contrast that one would reasonably expect that TEM could detect the formation top; (2) borings where the logs showed a poor resistivity contrast unfavorable to TEM detection; and (3) borings with formation-top picks but no available resistivity logs. Thus, all available boring-TEM comparisons are compared.

Most of the TEM models do not have a conductive layer corresponding to the top of the Cockfield Formation ("ND" in the table). Three soundings should have shown the formation but don't; others occur where resistivity logs show little resistivity contrast at the boundary, and a few are adversely affected by signal-depletion or cultural effects. Only three soundings "pick" the top of the Cockfield Formation, an expected result, considering the heterogeneous character of the formation.

The situation is somewhat more favorable for detecting the top of the Cook Mountain Formation, as shown in Table G-4. Half the TEM soundings are not interpretable for the formation's top, usually because signal-depletion and cultural effects dominate certain soundings in late time. Soundings which interpret the formation top often have significant errors in picking the elevation. Some of picks exceed the $\pm 15\%$-of-depth rule of thumb. More will be said about this later. There is a hint that the error is larger for stations which did not model a loess conductor (indicated by "*" in Table G-4).

Table G-3
TEM Picks of the Top of the Cockfield Formation at Logged Borings

Drilling Results			TEM Results			
Boring (Sh:...)	**Top of Cockfield (gamma logs) (feet)**	**Resistivity Contrast**	**TEM Station**	**Top of Cockfield (TEM model) (feet)**	**TEM Error (feet)**	**TEM Error (% of depth)**
Borings at which resistivity logs favor TEM detection						
V-74	220.5	good	3	ND(3)	—	—
			9	ND(1)	—	—
			34	ND(1)	—	—
			89	ND(3)	—	
V-80	222.1	good	203	218.2	-3.9	-9%
			204	ND(1)	—	—
Borings at which resistivity logs *do not* favor TEM detection						
U-98	188.0	fair	58	ND(2)	—	—
U-99	199.1	fair	22	ND(2)	—	—
			23	ND(2)	—	—
U-102	200.8	poor	91	ND(2)	—	—
V-76	206.0	fair	14	ND(2)	—	—
			15	ND(2)	—	—
V-79	219.2	fair	140	ND(3)	—	—
Borings with formation picks but with no available resistivity logs for the Cockfield interval						
U-60	205	?	63	210.3	5.3	6%
060G01	195	?	21	187.7	-7.3	-10%

The following boring/TEM clusters show undetected top of Cockfield in the TEM models: U-58/92; U-91/91; V-4/19,72; V-75/50,51; V-78/207,208; V-81/47; BG-2/192,193; BG-4/133,134; BG-5/218; BG-6/83; BG-10/49; BG13/30; 002G10/198; 005G05/59; 007SB01/86; 007SB03/87; 009G01/202; 009G04/156,157; 014G06/160,161; 065G06/199.

Notes:

ND = not detected, attributed to the following reasons:

(1) = no obvious explanation; (2)=poor contrast or insufficient separation of resistivity layers; (3)=TEM affected by signal depletion or cultural effects.

Table G-4
TEM Picks of the Top of the Cook Mountain Formation at Logged Borings

Drilling Results			TEM Results			
Boring (Sh:...)	**Top of Cook Mtn. (gamma logs) (feet)**	**Resistivity Contrast**	**TEM Station**	**Top of Cook Mtn. (TEM model) (feet)**	**TEM Error (feet)**	**TEM Error (% of depth)**
Borings at which resistivity logs favor TEM detection						
U-98	106.0	good	58	106.6	0.6	0%
U-99	164.0	good	22	178.1	14.1	9%
			23	183.4	19.4	12%
V-74	89.9	good	3*	ND(3)	—	—
			9	81.4	-8.5	-4%
			34	ND(3)	—	—
			89	ND(3)	—	—
V-79	92.9	good	140	ND(3)	—	—
V-80	113.8	good	203	84.0	-29.8	-19%
			204	81.7	-32.1	-21%
Borings at which resistivity logs *do not* favor TEM detection						
U-58	141	poor	92	ND(2)	—	—
V-75	129.9	fair	50*	98.4	-31.5	-16%
			51*	110.2	-19.7	-10%
V-76	102.4	fair	14*	ND(3)	—	—
			15*	ND(3)	—	—
V-78	121.1	poor	207*	92.8	-28.3	-13%
			208*	88.9	-32.2	-15%
Borings with formation picks but with no available resistivity logs						
007SB1	104	?	86	104.7	0.7	0%
007SB3	109	?	87*	ND(3)	—	—
U-60	145	?	63*	ND(3)	—	—
V-4	107.9	?	19*	ND(3)	—	—
			72*	ND(3)	—	—

Notes:
ND = not detected, attributed to the following reasons: (1)=no obvious explanation; (2)=poor contrast or insufficient separation of resistivity layers; (3)=TEM affected by signal depletion or cultural effects.
* = loess conductor not used in this model.

Table G-5 summarizes the ability of TEM to map these two formations. The data are segregated according to how favorable the resistivity structure is to TEM detection, but the most important results (in bold) are for the full data set, because these results suggest how well "uncalibrated" TEM soundings can be interpreted for structure.

Table G-5 shows the Cockfield Formation is rarely mappable with TEM due to the variability of its resistivity structure (most downhole logs show little resistivity contrast at the top of the formation, or a complex resistivity pattern). In the interpreted models, the top of the Cockfield Formation is picked in 16 of 199 soundings, for a pick rate of 8%. Limited data summarized in Table G-3 suggest that the elevation picks are reasonable compared to the 15% rule of thumb.

Table G-5
Summary of the Ability of TEM to Map Structure

	TEM Detection Rate (% of TEM Soundings)	Accuracy in Picking Top Elevation (feet)
Cockfield Formation		
• Borings at which resistivity logs favor TEM detection (2 logged borings, 6 TEM soundings)	(17%)	(-4%)
• **All borings with formation picks (29 borings, 42 TEM soundings)**	**7%**	**-2±7%**
Cook Mountain Formation		
• Borings at which resistivity logs favor TEM detection (5 logged borings, 10 TEM soundings)	61%	-6.1±21.7
• **All borings with formation picks (13 borings, 22 TEM soundings)**	**50%**	**-13.4±19.5**

Note:
Values in (parentheses) are uncertain due to an insufficient statistical sample.

The detection rate for the Cook Mountain Formation in Table G-5 is approximately 50%. Non-detections are common due to signal-depletion and cultural effects in the TEM data, and secondarily due to insufficient resistivity contrast in some areas. In the interpreted models, the top of the Cook Mountain Formation is picked in 51 of 199 soundings, for a pick rate of 26% — well below what might be expected from the predicted 50% detection rate. The reason is that it is easier to pick the top of this unit near the borehole control than in outlying areas; therefore the detection rate declines away from borehole control. Generally, a conservative approach was used to make picks of this formation top. Whenever there were significant uncertainties in the data responses, or ambiguities as to which TEM layer should be attributed to the Cook Mountain Formation, no TEM pick was made.

A negative bias of -13 feet is calculated in the TEM-picked elevations of the top of the Cook Mountain. Part of this bias probably arises from the small number of available comparisons and the scatter in the TEM picks. Hence, the bias may be purely statistical in origin. It is also possible that part of the bias may be due to modeling artifacts from unresolved near-surface conductors.

Bias and scatter limit the ability of TEM to map the top of the Cook Mountain Formation. To quantify this limitation, it is reasonable to remove the bias from the data set and consider the one-standard deviation scatter ($\pm$19.5 feet) as uncertainty bounds. Variations exceeding these uncertainty bounds would be considered to be statistically significant. Note that this error estimate implicitly includes all precision and accuracy errors (repeatability and spatial aliasing), and hence is most representative of the TEM data set's performance in structure mapping.

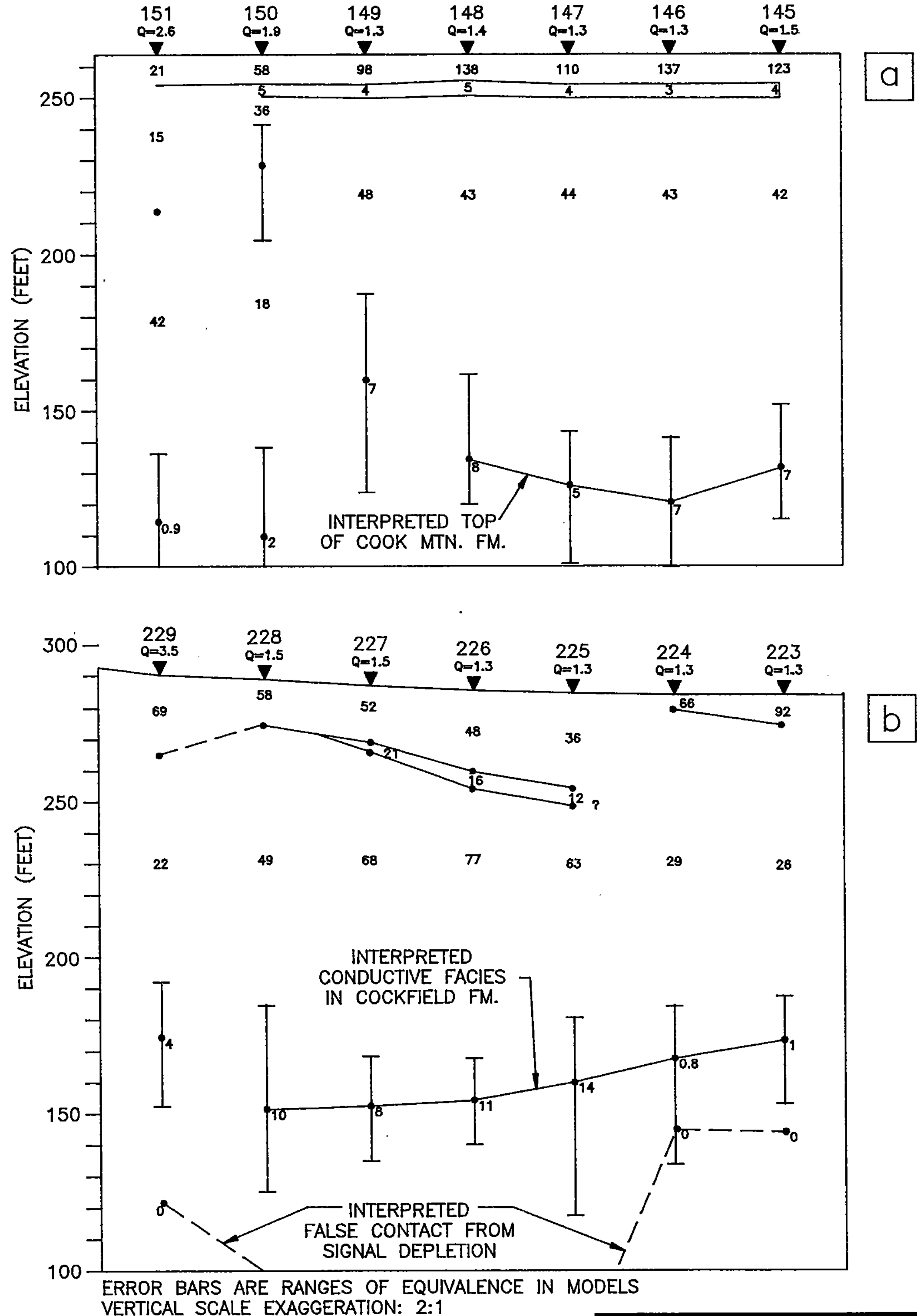
TEM is unsuccessful in picking the top of the fluvial unit because the logs show there are no distinct resistivity changes there. The best picks are invariably too high and correspond to the base of a conductive subunit within the lower loess. Thus TEM adds no new information to the database for the top of the fluvial unit.

G.3.5 Spatial Aliasing

Spatial aliasing occurs when the distance between sampling points is larger than the spatial variations present. For example, acquisition of two or three soil samples on a large site with isolated spots of contamination would result in heavily aliased data. Instead, one would have to choose between a dense sampling grid scheme or a statistically based sampling scheme to adequately characterize the soil contamination. The sampling design is usually a compromise between the desire to obtain minimally aliased data and the budget constraints of the project.

Although geophysical data usually have a higher sampling density than borings, nearly every geophysics data set is aliased to some degree. This is especially true of data sets like the present one, where many data come from isolated TEM stations. Three test traverses of contiguous TEM stations were made during this study, and the modeled results of two traverses are shown in Figure G-15 (the third traverse was over culture, and is not a proper aliasing test). Models are shown because they best demonstrate the uncertainty involved in picking the top of a geologic feature such as the Cook Mountain Formation. Most contacts are smoothly changing, with elevations within the range-of-equivalence error bars. Disruptions occur in areas of greater cultural influence (indicated by higher "Q=..." values beneath the station number). Disruptions also occur in the lower layers where the model changes character. For example, between stations 225 and 224, the shallow loess conductor appears to pinch out because the simplest fit to the data does not require it at station 224. However, this change in model character results in modeling a false contact in the lower part of the plot.

The nominal TEM station separation at NSA Mid-South is approximately 1,000 feet, so the two aliasing tests over about one-third this distance do not answer all the questions about aliasing. However, the tests suggest that aliasing may be less important than other sources of interpretational error on this project.



RCRA FACILITY INVESTIGATION
NSA MID-SOUTH
MILLINGTON, TN

FIGURE G–15
SPATIAL ALIASING TESTS

DWG DATE: 09/25/98 | DWG NAME: 0094G014

This page intentionally left blank.

G.4 INTERPRETATION

SECTION G.4 SUMMARY

This section describes two competing geological conceptual models based on a series of geologic maps obtained from TEM and borehole data.

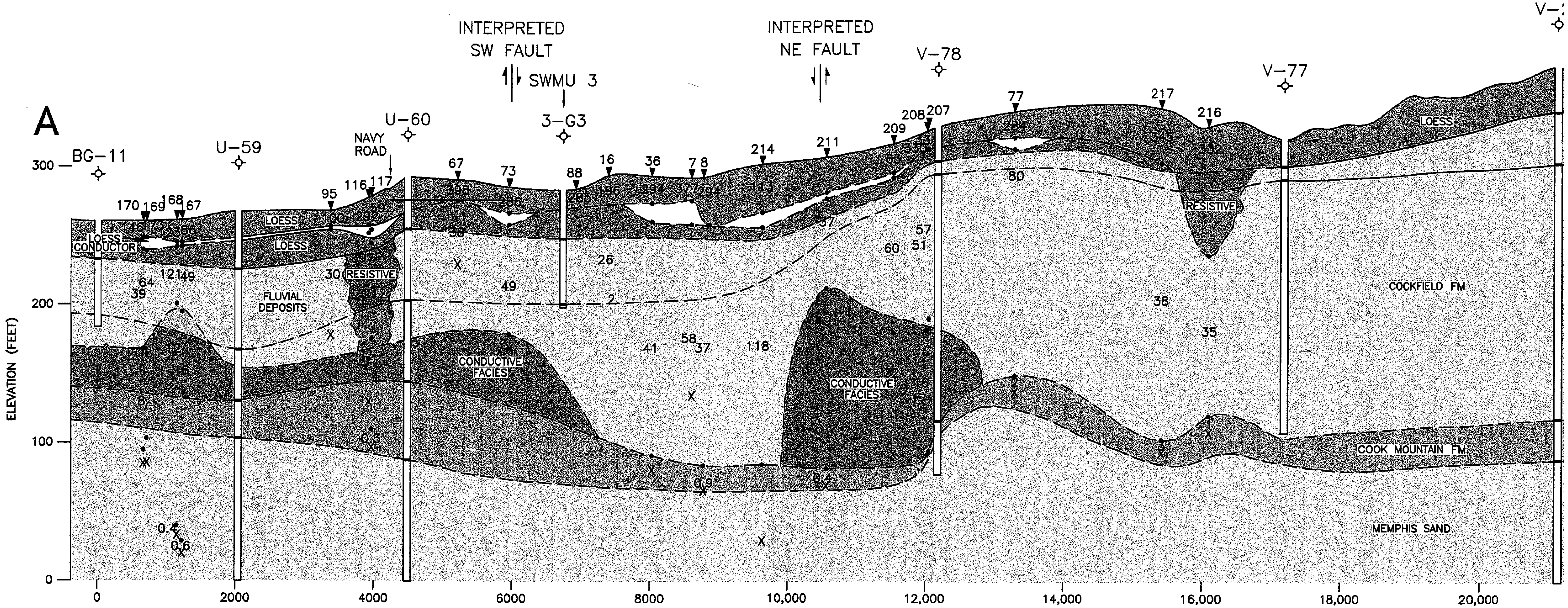
Maps of the tops of several formations were constructed from an integrated data set combining TEM and borehole picks. The tops of the fluvial deposits and the Cockfield Formation show a distinct rise toward the northeast part of NSA Mid-South, and the latter shows a narrow ridge extending southward in its central part. The map of the top of the Cook Mountain Formation shows a sinuous low zone suggestive of a paleo-erosional channel. Most of this feature is defined by TEM picks; the less dense borehole data fall outside or on the edge of the channel. A test of the channel's statistical significance was performed using a bias and scatter analysis of the TEM picks derived from the evaluation (-13.4 ± 19.5 feet) in Section G.3. Based on this test, the channel is statistically valid.

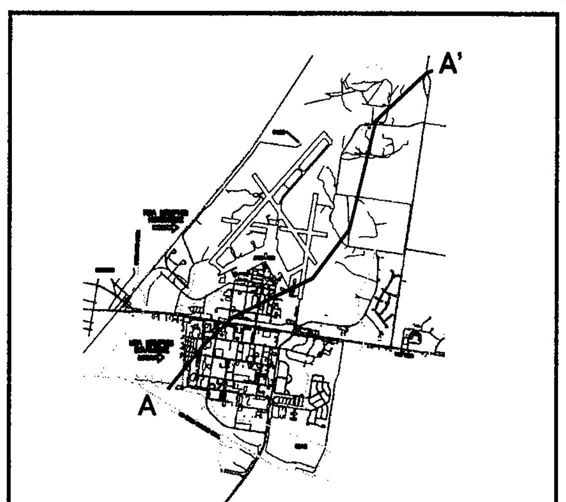
Previous work by Carmichael et al., (1997) had interpreted a faulted graben block with no channel. The TEM-geologic model interprets a channel with no faulting. These two conceptual models appear to be incompatible. Both are geologically plausible, and each has strengths and weaknesses. Our interpretation is that the fault model is slightly preferred to the paleo-channel model, based on an apparent hydrologic depression near one of the interpreted faults. However, the depression is poorly characterized, and if it is discredited in future field work, we would slightly prefer the paleo-channel model.

G.4.1 Cross-Section Interpretation

Numerous cross-sections were constructed to interpret this data set. Figure G-16 is one example, drawn with a 20:1 vertical scale exaggeration (location shown in the inset map; control points are shown in Plate G-1 at the rear of this Appendix). Formation contacts are drawn according to the geologic control, augmented by TEM picks when available. Layer resistivities from the TEM models are shown; remember that these are biased low and have considerable scatter for values exceeding 10 ohm-meters.

This page intentionally left blank.





CROSS SECTION LOCATION

2000 0 2000

SCALE FEET

VERTICAL EXAGGERATION 20:1

LEGEND

- BOREHOLE
- 67 / 398 / ● / 38 — TEM STATION AND ID, TEM CONTACT (" "), AND LAYER RESISTIVITIES
- X — END OF USEFUL TEM DATA

RCRA FACILITY INVESTIGATION
NAVAL SUPPORT ACTIVITY MID-SOUTH

FIGURE G-16
JOINT GEOLOGICAL/GEOPHYSIC/
INTERPRETATION
CROSS SECTION A-A'

DWG DATE:02/03/00 | DWG NAME:094CF

This page intentionally left blank.

TEM determines a resistivity contact at roughly the middle of the loess, perhaps corresponding to the transition to higher clay content between stratigraphic equivalents of the Peoria Loess and Roxanna Silt (see Carmichael et al., 1997). The contact is often accompanied by the modeled "loess conductor." As mentioned earlier, this thin unit is preferred in some models, but unnecessary in others. Its geologic explanation is not clear at this time.

The fluvial deposits become thin in the higher areas to the northeast, whereas the Cockfield sediments thicken. The "conductive facies" are indicated in deep tan where a change in resistivity is interpreted within the Cockfield Formation.

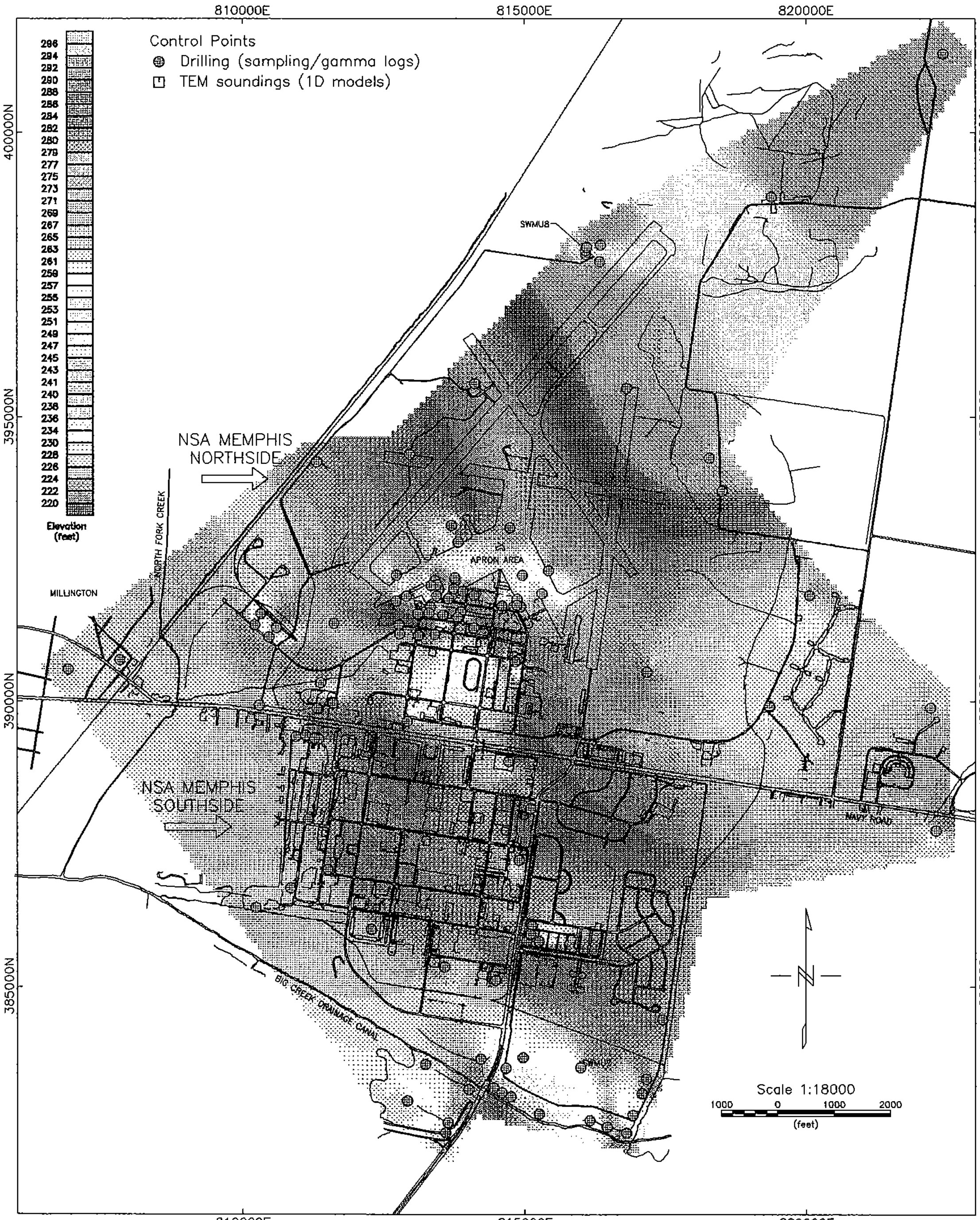
The Cook Mountain contact is defined primarily by geologic data, supplemented by some TEM picks. At the center of the cross-section is an apparent topographic low in the Cook Mountain Formation. However, given the inherent errors in the TEM picks for this formation, the low is not very convincing in this one cross-section; only the plan-view plots, presented later, suggest that this might be a real geologic feature.

G.4.2 Plan-View Interpretation

Figures G-17 to G-19 and G-23 to G-25 present geologic maps interpreted from the integrated geophysical and geological data sets. In each figure, the data control points are shown by gray dots (results of drilling, logging, or sampling) and yellow boxes (results of 1D models of TEM data). Some plots are based entirely on borehole data, others upon both data sets. Warmer colors (orange through magenta) represent higher data values (e.g., higher elevation, thickness, or resistivity), and cooler colors (green through blue) represent lower data values. Areas of poor data control are not color-shaded, producing the sometimes odd shaped color boundaries.

Figures G-17 to G-19 show the interpreted formation tops. Some of the data are from Carmichael et al., (1977), who made their correlations primarily from gamma logs. Other picks are by EnSafe, made from lithologic descriptions with or without the aid of induction logs, from rotasonic logs, or from TEM data.

This page intentionally left blank.



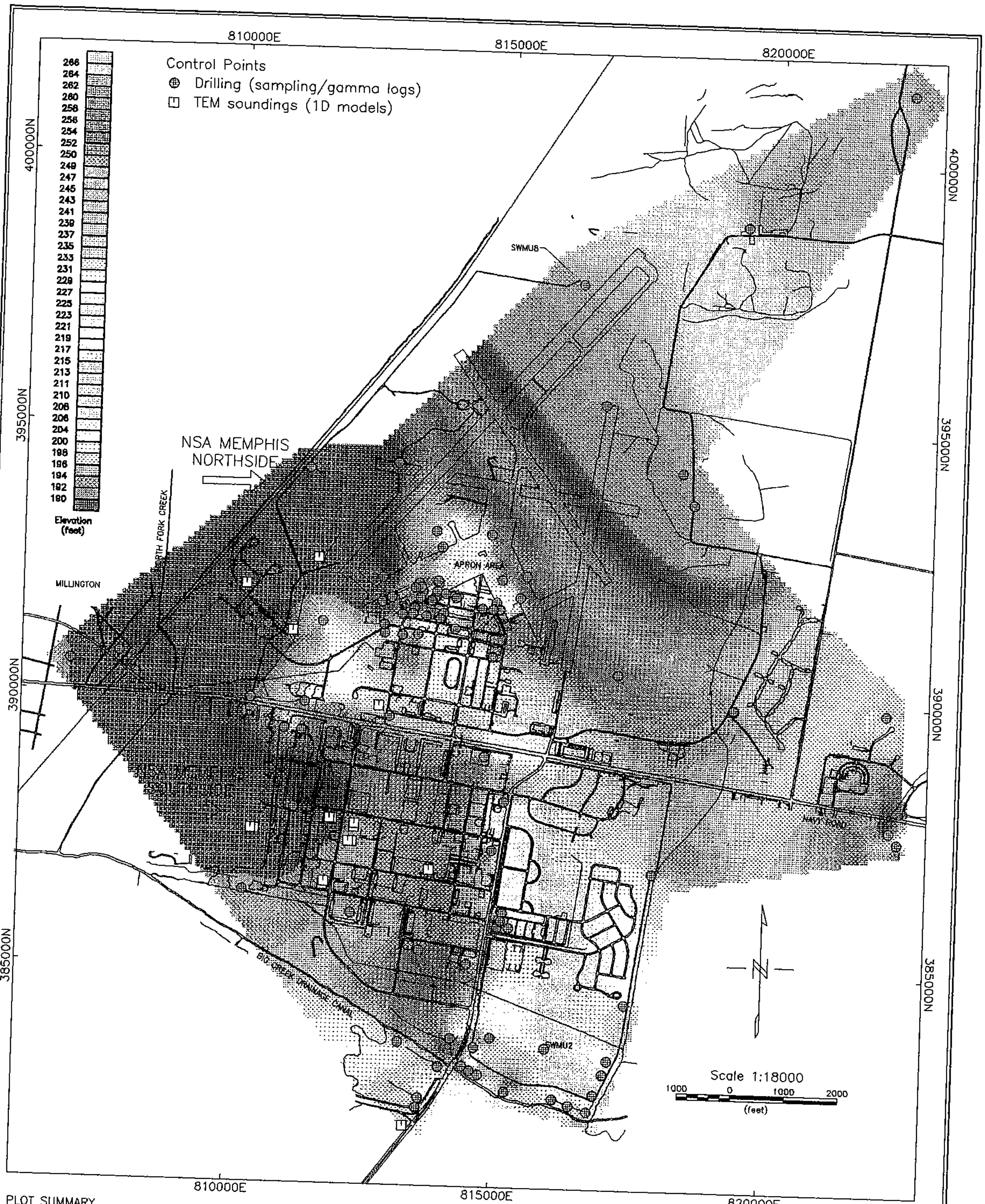
PLOT SUMMARY
- Data from drilling alone (no TEM picks for fluvial deposits)
- CAD drawing 106LHWAT.DXF
- Plot file A.P01 generated 9-22-98 via Geosoft

Figure G-17

TOP OF THE FLUVIAL DEPOSITS

RCRA Facility Investigation
Naval Support Activity Mid-South
Millington, Tennessee

This page intentionally left blank.



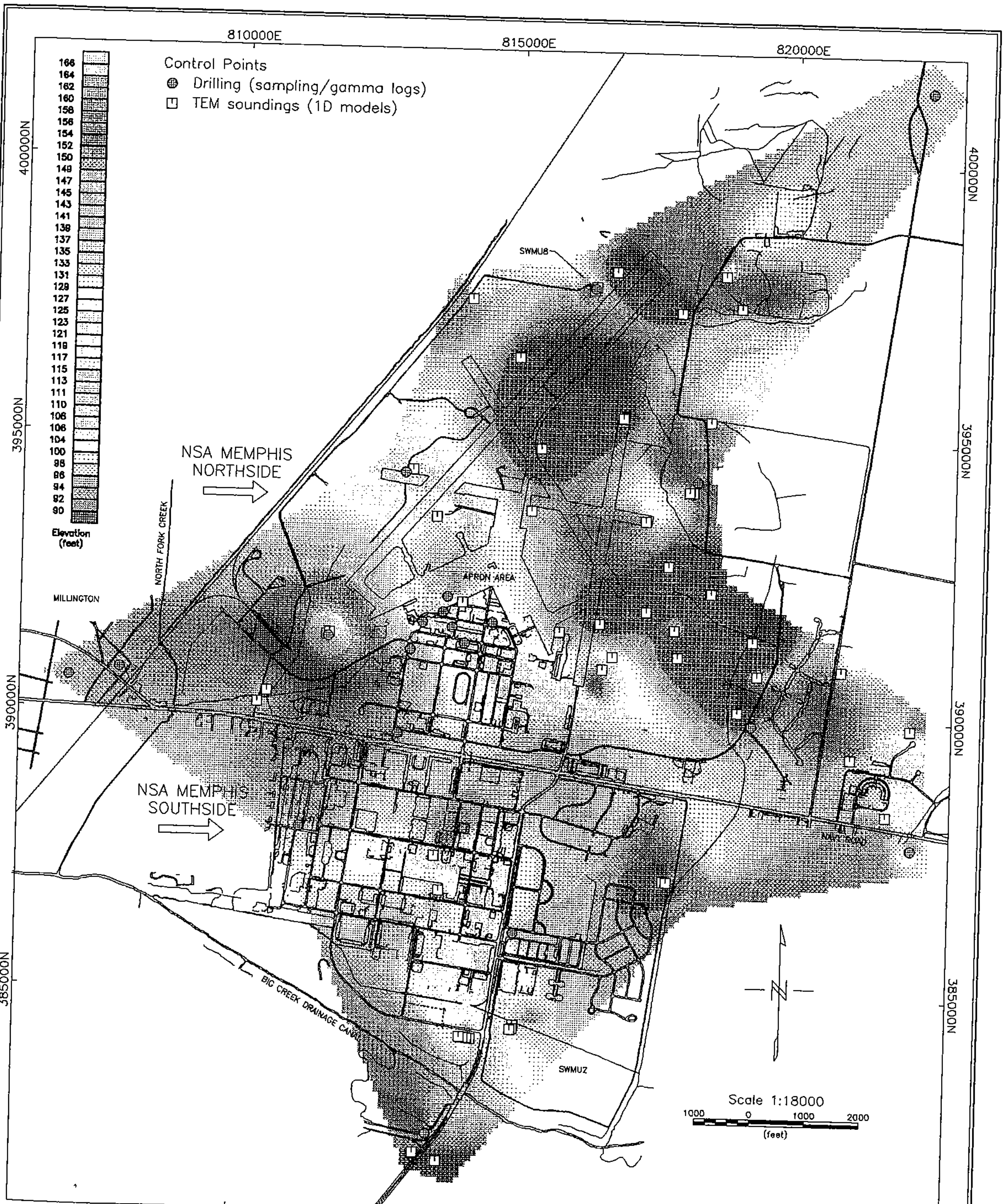
PLOT SUMMARY
- Data from drilling and TEM models
- CAD drawing 106LHWAT.DXF
- Plot file B.P01 generated 9-22-98 via Geosoft

Figure G-18

TOP OF THE COCKFIELD FORMATION

RCRA Facility Investigation
Naval Support Activity Mid-South
Millington, Tennessee

This page intentionally left blank.



PLOT SUMMARY
Data from drilling and TEM models
CAD drawing 106LHWAT.DXF
Plot file C.P01 generated 9-22-98 via Geosoft

Figure G-19

TOP OF THE COOK MOUNTAIN FORMATION

RCRA Facility Investigation
Naval Support Activity Mid-South
Millington, Tennessee

This page intentionally left blank.

Top of the Fluvial Deposits — The fluvial deposits (Figure G-17) show a high zone to the northeast, dropping abruptly, then leveling out to the southwest. The paleoslope change may be the result of terrace deposits or other mechanisms.

Top of the Cockfield Formation — This unit (Figure G-18) mimics the high elevations observed in the fluvial deposits map. The plot also shows a ridge-like structure oriented in a north-south direction beneath the present-day Seventh Avenue. The relief is less than 20 feet. Carmichael et al., (1997) show a similar feature at the base of the fluvial deposits and lower alluvium.

Top of the Cook Mountain Formation — The plot of the Cook Mountain Formation's top (Figure G-19) shows a sinuous, trough-like depression, oriented roughly in a north-south direction. Most of the control for this feature is provided by TEM; some eight boreholes lie near the boundaries of the interpreted feature, but none intersect it in its middle. The depression is bounded to the west by a broad, elevated area, highlighted by the unusually high point at borehole U-99. An elevated area also appears to lie east of the valley-like feature, but control in this direction is limited.

Since the interpreted depression depends on TEM picks of the top of the Cook Mountain Formation, it is necessary to examine the statistical significance of the TEM results. As noted earlier, TEM picks of the Cook Mountain Formation top, compared to nearby borehole control, averaged -13.4 ± 19.5 feet. The bias of -13.4 feet is thought to be largely an artifact of insufficient statistics. However, under the most conservative assumption that this is a true bias in TEM, 13.4 feet were subtracted from the TEM picks, and the ± 19.5 feet standard deviation was considered to be the bounds of statistical significance. In other words, for a given TEM-interpreted elevation of the Cook Mountain Formation, any values that differ by more than ± 19.5 feet from it are considered statistically significant.

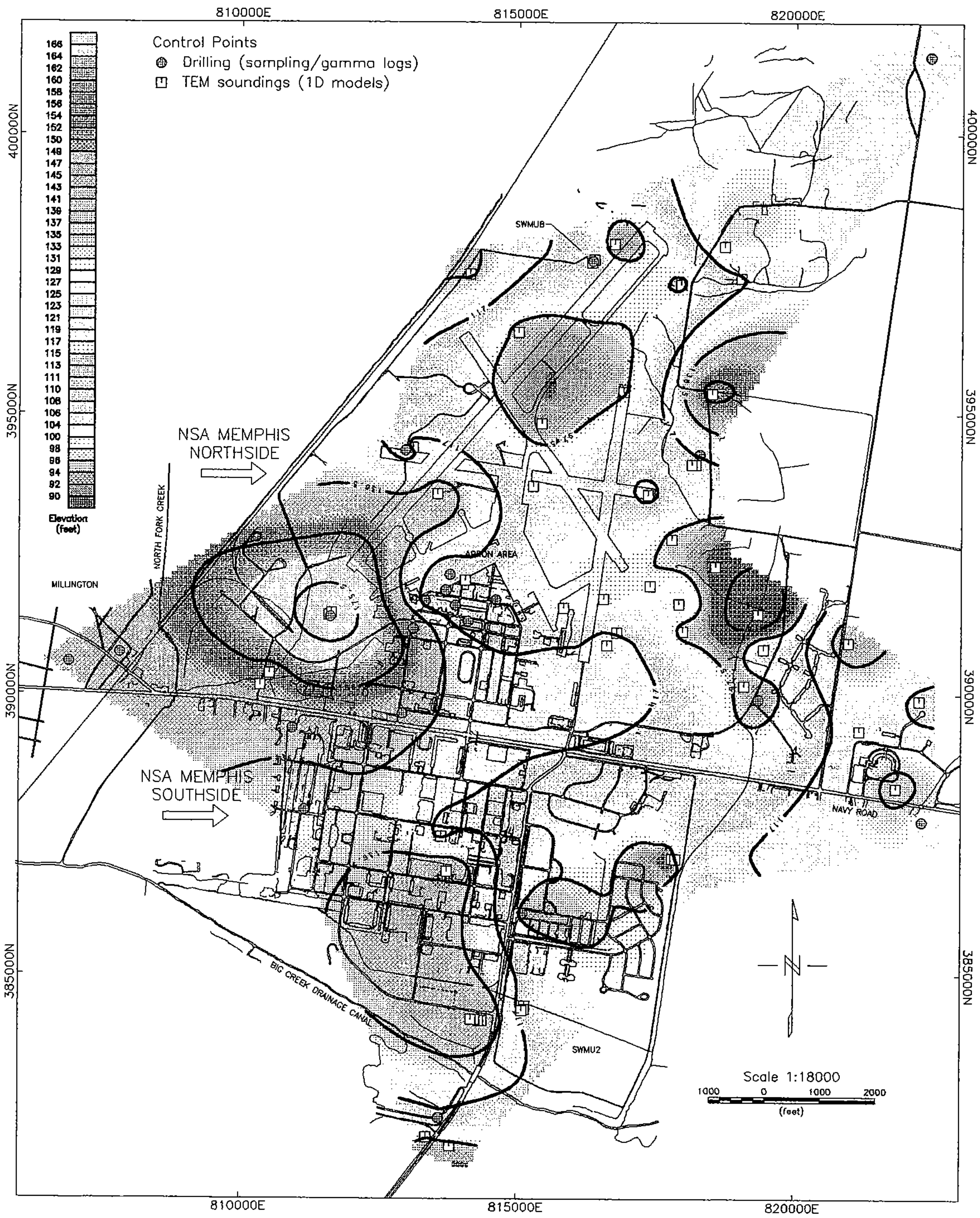
The results of this test are plotted in Figure G-20. Blue contours are drawn every 19.5 feet (one standard deviation, arbitrary zero datum). The depression's elevation differs from elevations of surrounding higher areas by 1.5 to 3 standard deviations. It is also worth noting that the depression has spatial coherence, which would not be expected if it were an artifact of data scatter. Thus, the depression appears to be statistically significant.

It should be noted that statistical significance does not prove the depression is real. It is an interpreted feature, based on correlations with borehole control. Wrong picks of formation tops in borehole data, incorrect attribution of specific TEM layers to geologic layers, and undetected bias of TEM models are all potential sources of error. However, based on a careful examination of these issues, the depression feature is interpreted to be a real feature of geologic origin.

G.4.3 Geologic Conceptual Model

It is proposed that the present study maps an erosional paleo-channel in the top of the Cook Mountain Formation. The channel appears to be 2,000 to 3,000 feet wide, suggesting a paleo-river or meandering stream system. The sinuous shape depicted in Figure G-19 is consistent with this interpretation. Its edges are characterized by slopes of 5 degrees or less, also consistent with erosional processes.

The geologic data in this area have been interpreted as a faulted graben structure by Carmichael et al., 1997), contrasting with the model proposed here. These two models, referred to as the "Fault Model" and the "Paleo-channel Model," are depicted in Figure G-21. Figure G-21, redrawn from Figure 13 of Carmichael et al., shows their proposed graben feature, bounded by two faults, and cut to the southeast by a bounding normal fault. These structures were interpreted to cut Eocene to Paleocene sediments, not more recent units at or above the top of the Cockfield Formation. Figure G-21, redrawn from Figure G-19, shows the interpreted paleo-channel. Attempts to harmonize these two different scenarios were unsuccessful. Thus, the models appear to represent distinct and mutually exclusive interpretations of the available data.



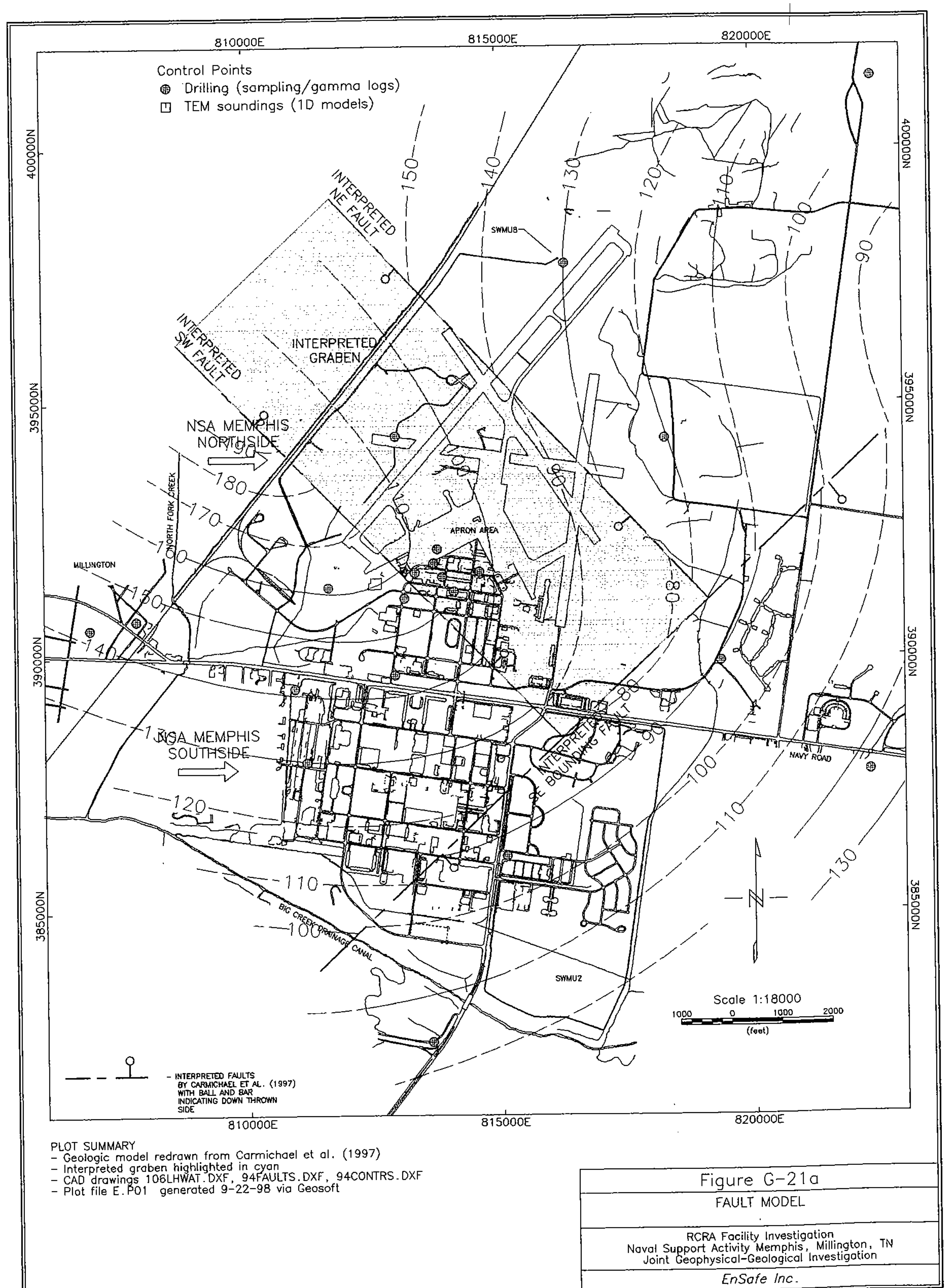
PLOT SUMMARY
- Data from drilling and TEM
- -13.4 ft. bias removed, contoured every standard deviation
- CAD drawing 106LHWAT.DXF
- Plot file D.P01 generated 9-22-98 via Geosoft

Figure G-20

TOP OF THE COOK MOUNTAIN FORMATION
(TEST OF STATISTICAL SIGNIFICANCE)

RCRA Facility Investigation
Naval Support Activity Mid-South
Millington, Tennessee

This page intentionally left blank.



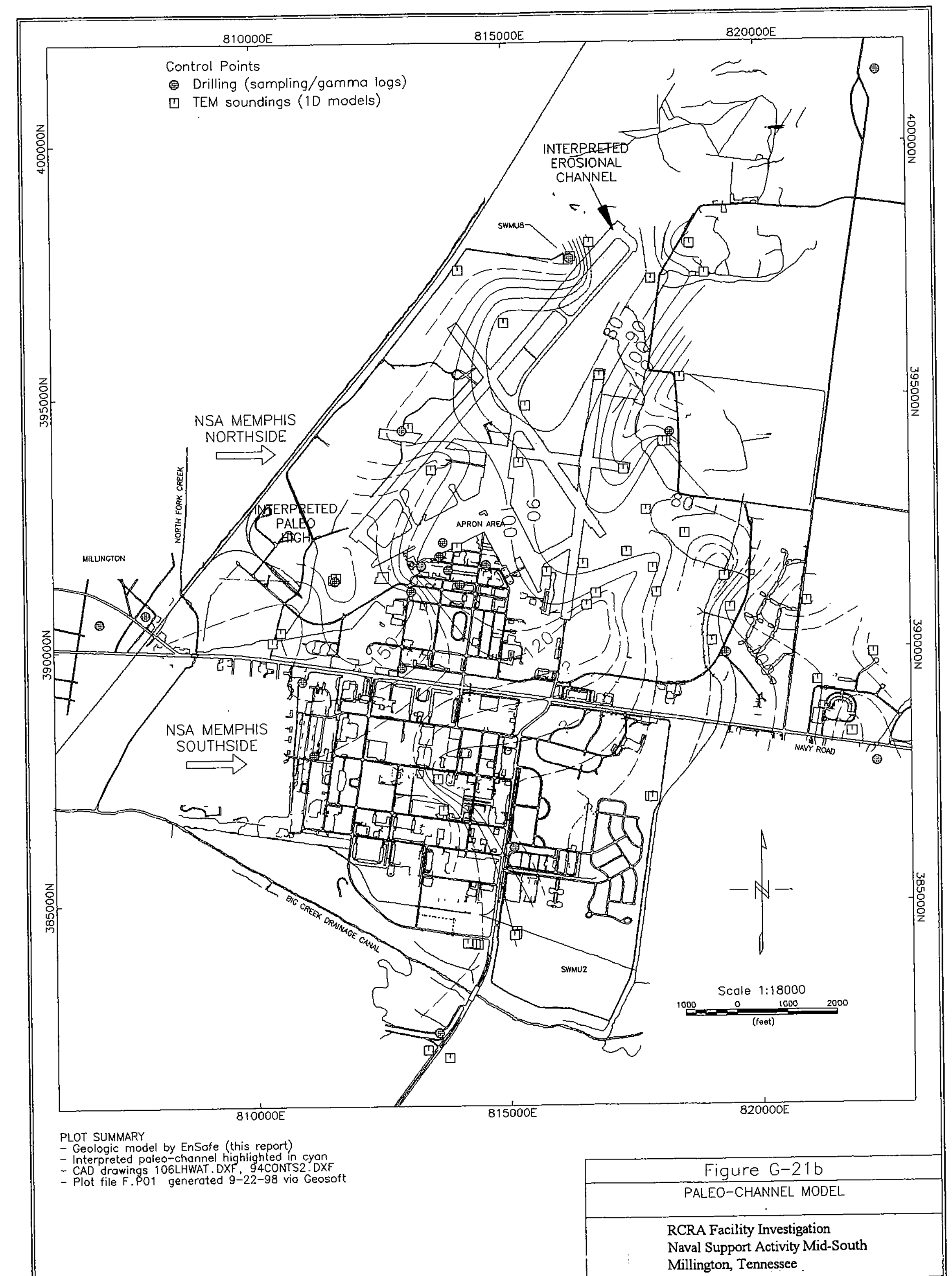


Fig. 21. *Two geologic conceptual models.*

This page intentionally left blank.

One additional piece of information crucial to the evaluation of these models is the apparent hydrologic behavior in the fluvial aquifer. Figure G-22 shows groundwater elevations in the fluvial deposits from data obtained in April 1996. The data are from upper fluvial, lower fluvial, and deep alluvium wells (local differences between these units are insignificant at this larger scale; see Figure 2-2 in the main report). The data depend on a crucial assumption: that groundwater in the terrace deposits at the north end of the facility (SWMU 8 area) is hydraulically interconnected with the fluvial deposits aquifer to the south. It is not entirely clear at this time whether or not this assumption is true.[1]

A broad groundwater high in the central part of the site appears to rise more sharply to the northeast, assuming hydraulic interconnection. At the transition between these two regimes, there appears to be a roughly linear groundwater depression. This depression is based on just a few available wells and on the assumption of hydraulic interconnection. But if the depression exists, it may suggest downward leakage along a northwest-southeast trend. Note that the interpreted NE bounding graben fault of Carmichael et al., is positioned in this area.

The strengths and weaknesses of each model are:

The Fault Model

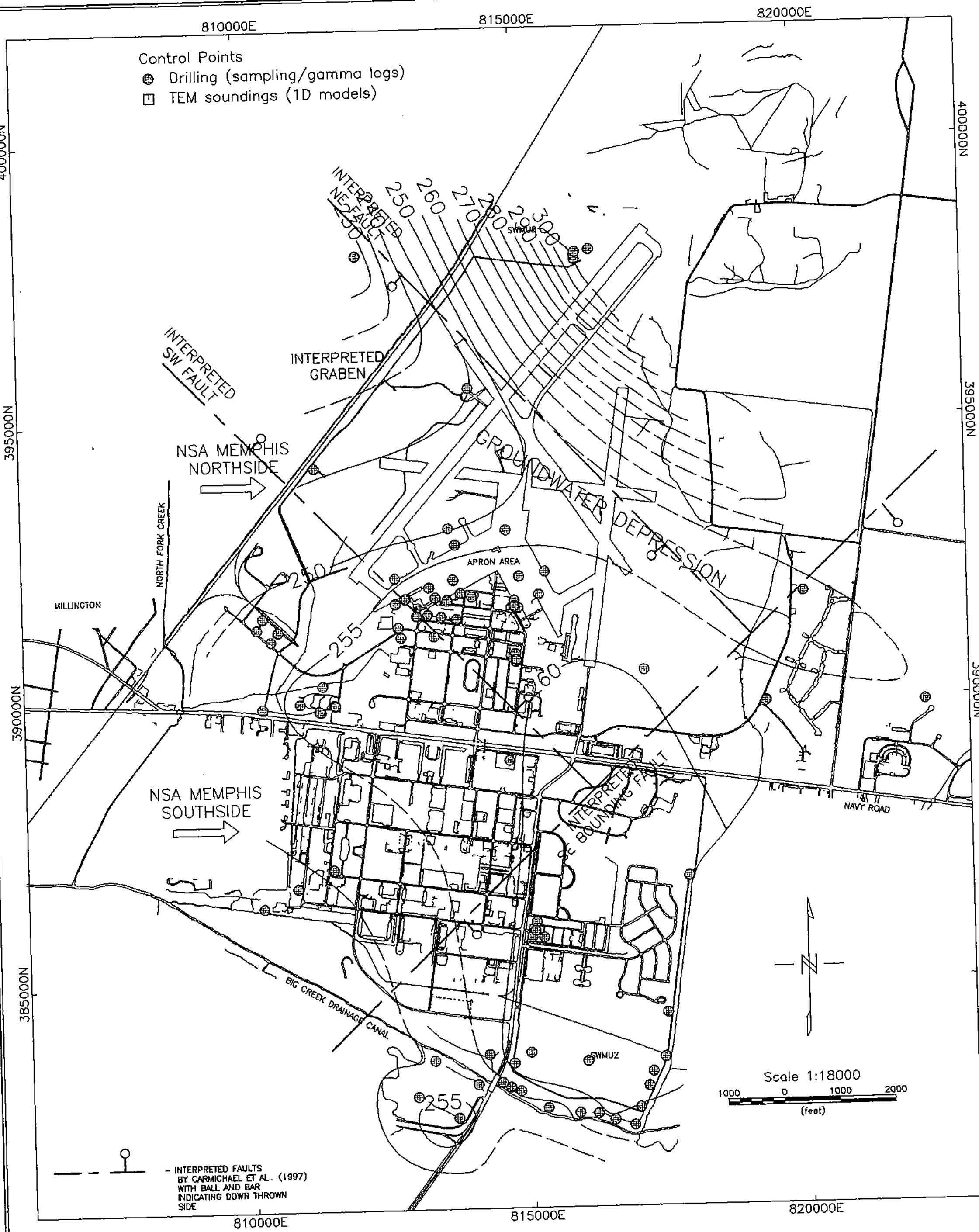
Strengths

- The model is a coherent, geologically plausible explanation of changes in formation tops and thicknesses.

- The model is reasonable compared to other interpreted faulting in southwest Tennessee.

[1] Later RFI activities identified groundwater in terrace deposits at depths comparable with the fluvial deposits south of SWMU 8. More recent potentiometric data indicate the absence of the linear depression in the fluvial deposits groundwater that was formerly coincident with the northeast fault from Carmichael et al., and shows groundwater continues to flow in a northwestward direction in this area.

This page intentionally left blank.



PLOT SUMMARY
- Data from 4/96 groundwater level measurements at upper/lower fluvial deposits and deep alluvium wells
- CAD drawings 106LHWAT.DXF, 94CONTS3.DXF, 94FAULTS.DXF
- Plot file G.P01 generated 9-22-98 via Geosoft

Figure G-22

ELEVATION OF FLUVIAL DEPOSITS GROUNDWATER

RCRA Facility Investigation
Naval Support Activity Mid-South
Millington, Tennessee

This page intentionally left blank.

Weaknesses

- Except for the SWMU 7 area, spatial control of boreholes is insufficient to consistently interpret features smaller than several thousand feet in size. Thus, small or narrow features which could impact the model could have gone undetected.

- The largest slope change in any of the plots contoured by Carmichael et al., is less than 5 degrees; such a shallow slope does not require faulting to explain it.

- Because the affected sediments are unconsolidated and stratigraphically complex, definitive evidence of faulting (offsets in marker beds, slickensides, fault gouge, etc.), are not available.

- Undetected errors may exist in the geologic database due to incorrect gamma log picks because of complex heterogeneities within the Cockfield Formation.

Paleo-channel Model

Strengths

- The model is a coherent, geologically plausible explanation of changes in formation tops and thicknesses.

- The model offers a simpler explanation than graben faulting does.

- Spatial control is better because both borehole and TEM data are used.

Weaknesses

- The paleo-channel is largely interpreted from TEM data, and no borehole has been placed in its middle, preventing geologic confirmation.

- Uncertainties in the TEM interpretation, in addition to the indirect mapping character of geophysics in general, make the TEM data less reliable than the borehole data.

- Spatial control of boreholes is insufficient to consistently interpret features less than 1,000 to 2,000 feet in size. Thus, smaller or narrower features which could impact the model could have gone undetected.

- Undetected errors may exist in the geologic database due to incorrect gamma log picks because of complex heterogeneities within the Cockfield Formation; some of the TEM results are calibrated to these picks, and therefore could also be in error.

Which model is correct? Based on available information, we do not consider this issue to be resolved. Both models are plausible explanations of the available data. Additional drilling during the CMS phase could change this conclusion substantially.

G.4.4 Implications to Downward Contaminant Transport

The Cook Mountain Formation, and to a lesser extent, the Cockfield Formation, serves as confining units to the fluvial deposits aquifer and the Memphis Sand aquifer (Parks, 1990). Regional studies have shown local thinnings, windows, and pinchouts in these units in other parts of southwest Tennessee (Parks, 1990; Parks and Mirecki, 1992; Carmichael et al., 1997; Hoekstra et al., 1992). Are such features present at NSA Mid-South?

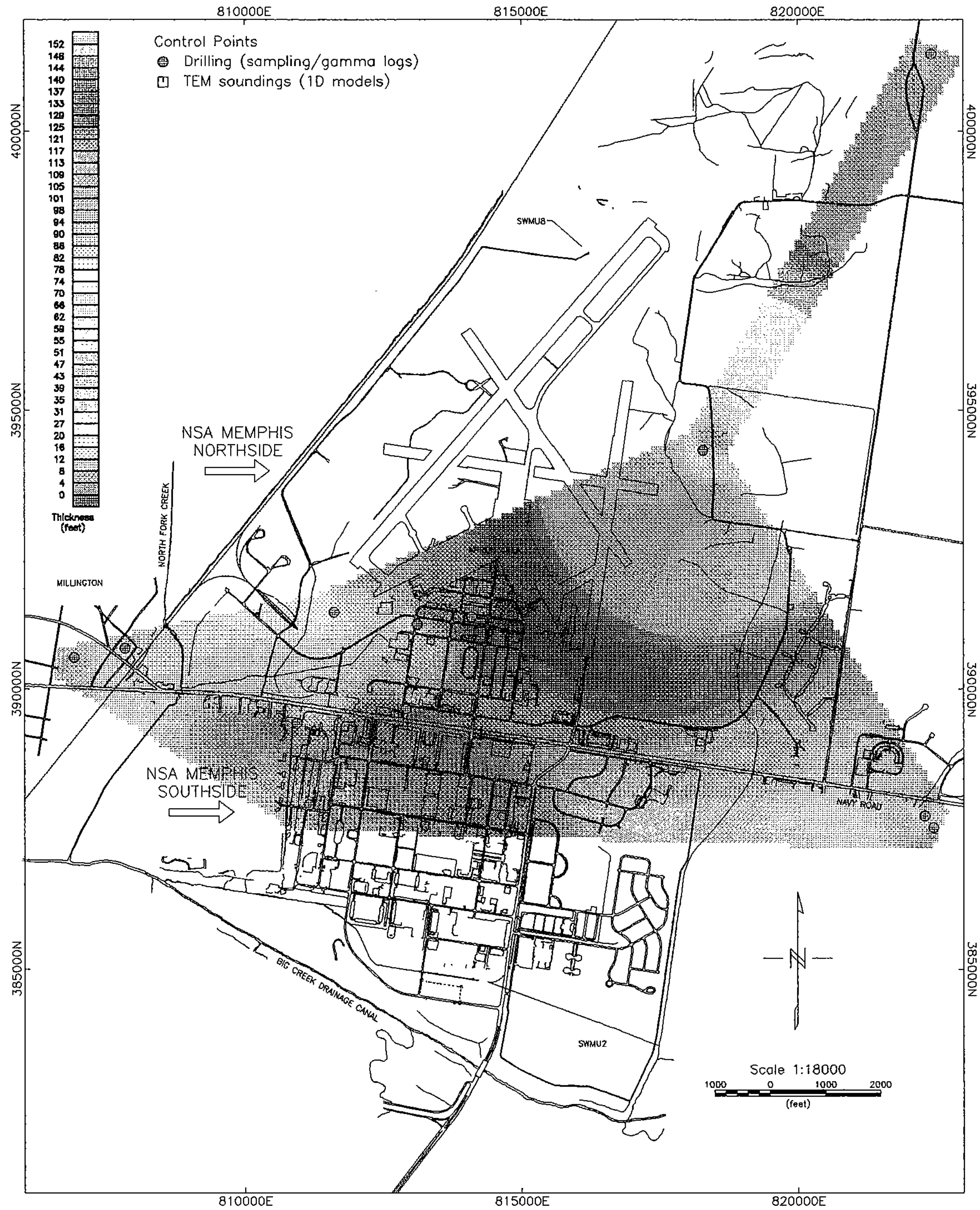
The Cook Mountain Formation, whose clays provide the most effective part of the confining unit, was encountered at every one of the 29 borings drilled to its depth. The Cockfield Formation was encountered at every one of the 107 borings drilled to its depth. Thus, based entirely on the available geologic data, there is no reason to suspect any windows or pinchouts in the UpperClaiborne confining unit within the NSA Mid-South area.

Are there stratigraphic thinnings? Figure G-24 shows the thicknesses of the Cockfield and Cook Mountain Formations, respectively. The Cockfield Formation thins to the west (corresponding to the depression in its erosional top, shown in Figure G-8). Minimum measured thickness in the NSA Mid-South area is 19 feet (U-48) . The Cook Mountain Formation varies in thickness, with a minimum of 12 feet (V-78). Figure G-23 shows the total thickness of the confining unit. For purposes of this plot, the entire thicknesses of the Cockfield and Cook Mountain Formations are summed, realizing that the Cockfield Formation has local zones of porosity due to lenses and stringers of fine sands. Since the base of the Cook Mountain Formation was tested at only a few borings, the spatial data coverage of this plot is limited. However, all borings show aggregate Upper Claiborne thicknesses exceeding 63 feet. Thus, major thinnings of the confining unit are not indicated in the NSA Mid-South area.

Having established the stratigraphic continuity of the Upper Claiborne confining unit, are there permeable pathways within it? The groundwater patterns in the fluvial deposits aquifer suggest this might be the case. Two possible "styles" of pathways are facies and faults.

Permeable facies such as sand lenses and stringers are present in many parts of the Cockfield Formation. But to establish a hydraulic connection to the Memphis Sand via this mechanism would require that these permeable zones be stacked atop each other and a coincident change to a sandy facies within the underlying Cook Mountain Formation. This seems very unlikely.

This page intentionally left blank.



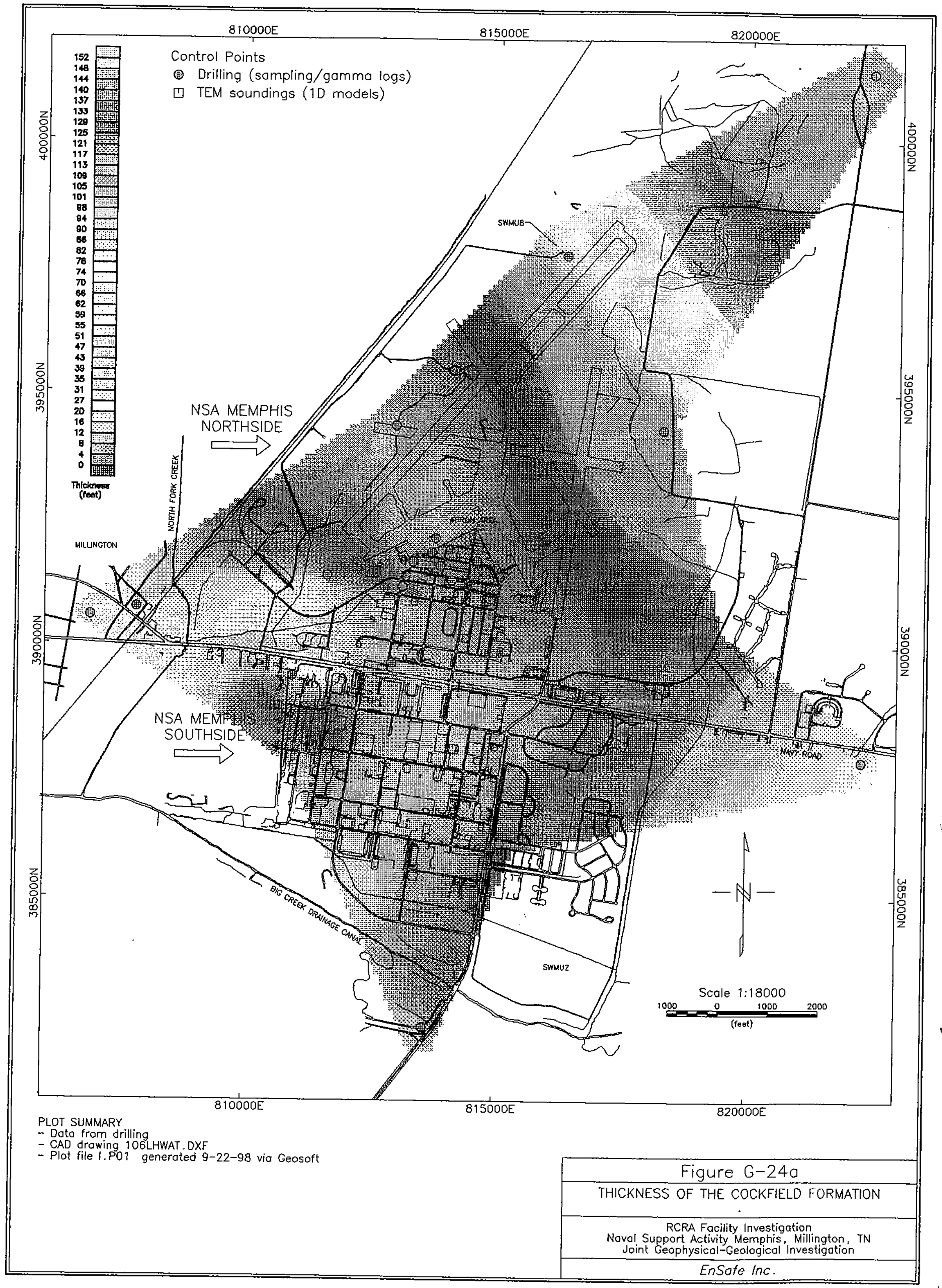
PLOT SUMMARY
- Data from drilling
- CAD drawing 106LHWAT.DXF
- Plot file H.P01 generated 9-22-98 via Geosoft

Figure G-23

THICKNESS OF UPPER CLAIBORNE UNIT
(COCKFIELD + COOK MOUNTAIN FORMATIONS)

RCRA Facility Investigation
Naval Support Activity Mid-South
Millington, Tennessee

This page intentionally left blank.



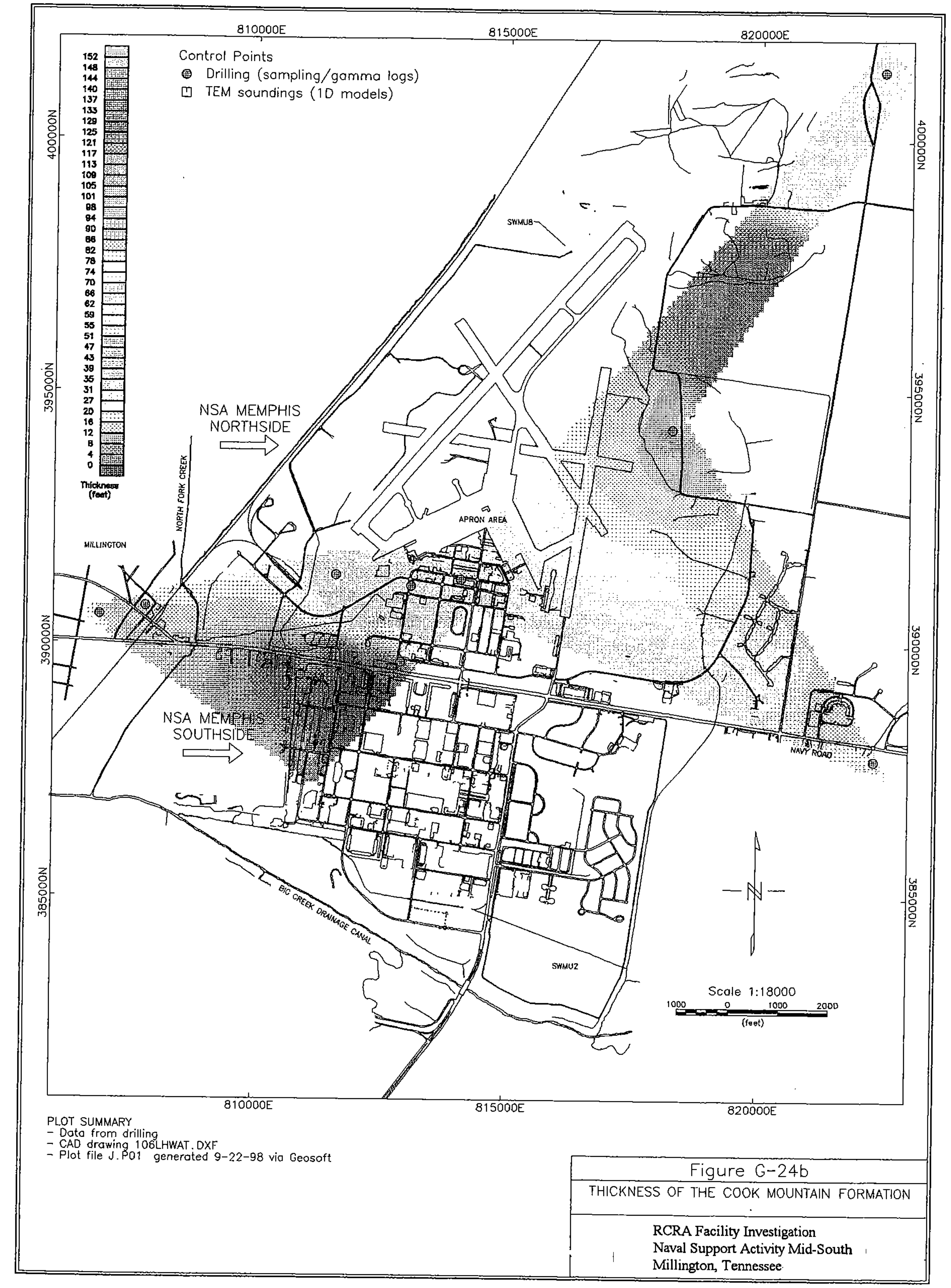


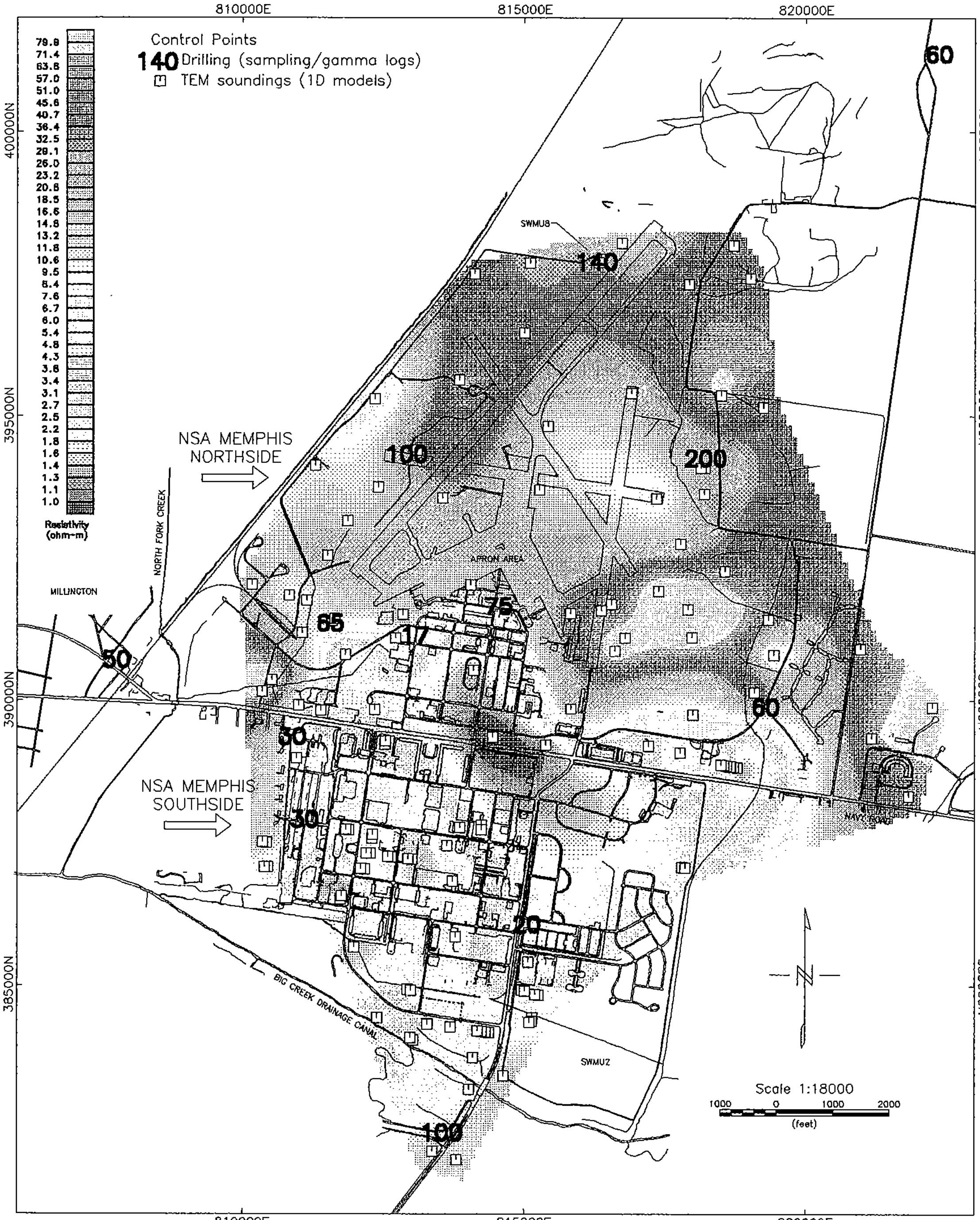
Fig. 24. *Thicknesses of the Cockfield and Cook Mountain Formations.*

This page intentionally left blank.

TEM resistivity data provide some useful information. Higher clay content in saturated sediments often lowers resistivities in geophysical data, and higher sand content often increases resistivities. Figure G-25 shows the resistivity of the lower Cockfield Formation. Color shading is based on TEM data, and resistivities from geophysical logs are posted in heavy black numbers. As expected from Figure G-14, there is a level shift in absolute resistivities between the two data sets, but the trends are well correlated. Note that higher resistivities are not observed along the trend of the groundwater depression. This does not rule out the presence of interconnected sand facies there, but it makes the fault hypothesis more probable (the fact that a fault is not indicated in Figure G-14 is inconclusive because the station spacing is not optimized for such a feature). A distinct zone of low resistivities (blues) occurs on the south-central part of the facility. One explanation is that this part of the Cockfield Formation contains a higher clay content. Insufficient geologic data exist to confirm this. However, if this interpretation is correct, the integrity of the confining unit would be enhanced in the very area where the unit gets thinner.

The second style of vertical permeability is faulting. Carmichael et al., (1997) suggest that proposed faults may not extend into the fluvial deposits. A comparison of the top of the Cockfield Formation (Figure G-18) and the location of their proposed faults (Figure G-21a) supports this assertion.

This page intentionally left blank.



PLOT SUMMARY
- Data from drilling
- CAD drawing 106LHWAT.DXF
- Plot file K.P01 generated 9-22-98 via Geosoft

Figure G-25

RESISTIVITY OF THE BASE
OF THE COCKFIELD FORMATION

RCRA Facility Investigation
Naval Support Activity Mid-South
Millington, Tennessee

This page intentionally left blank.

G.5 CONCLUSIONS

Two distinct, alternative structural models adequately explain observed changes in thicknesses and elevations of the Upper Claiborne confining unit. The Fault Model of Carmichael et al., (1997) proposes a complex, faulted graben feature, with a possible hydraulic connection between the fluvial deposits and Memphis aquifers along a northeast bounding fault (see earlier footnote 1). The Paleo-channel Model proposed here posits an erosional paleo-stream channel at the top of the Cook Mountain Formation. A few well-placed borings could confirm or refute the proposed channel. Hence, a limited effort may help resolve which geologic conceptual model is correct.

It remains to be shown if any hydrologic leak, if it exists, would permit the downward migration of contaminants from the fluvial deposits aquifer to the Memphis aquifer. A mechanical leakage path does not necessarily indicate a chemical leakage path, particularly because of the expected high carbon content (0.2 to 12 percent) of the Upper Claiborne units. This issue will be addressed in the upcoming CMS.

This page intentionally left blank.

G.6 REFERENCES

Auken, E., Christensen, N.B., Srensen, K.I., and Effers, F. (1994). Large Scale Hydrogeological Investigation in the Beder Area — A Case Study. Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems, Boston, 615-627.

Bostick, F.X. (1977). A simple almost exact method of MT analysis: Workshop on electrical methods in geothermal exploration, Snowbird, UT: U.S. Geological Survey Contract 14-08-001-6-359.

Buselli, G., Barber, C., and Williamson, D.R. (1986). The mapping of groundwater contamination and soil salinity by electromagnetic methods: Hydrology and Water Resources Symposium, Griffith University, Brisbane, 317-322.

Buselli, G., Barber, C., Davis, G.B., and Salama, R.B. (1990). Detection of groundwater contamination near waste disposal sites with transient electromagnetic and electrical methods: in Ward, S.H., Ed., Geotechnical and Environmental Geophysics, vol. 2, 27-39.

Carmichael, J.K., Parks, W.S., Kingsbury, J.A., and Ladd, D.E. (1997). Hydrogeology and Ground-Water Quality at Naval Support Activity Memphis, Millington, Tennessee. USGS Water-Resources Investigations Report 97-4158.

Chen, C-S. (1998). Mapping Plate Boundaries Using TEM Along the Longitudinal Valley, Taiwan. Geophysics, **63**, 868-879.

Christensen, N.B. (1995). 1D Imaging of Central Loop Transient Electromagnetic Soundings. Journal of Environmental & Engineering Geophysics, **0**, no.1, 53-66.

ERC (1990). Preliminary Review Document for RCRA/CERCLA Activities, NAS Memphis, Millington, Tennessee. ERC Environmental and Energy Services Co.

Fitterman, D.V. (1986). Transient electromagnetic sounding in the Michigan Basin for groundwater evaluation: in Proc. of the National Water Well Assn. Subsurface and Borehole Geophysical Methods and Ground Water Instrumentation Conf., Denver, 334-353.

Fitterman, D.V., Frischknecht, F.C., Mazella, A.T., and Anderson, W.L. (1990). Example of transient electromagnetic soundings in the presence of oil-field pipes: in Ward, S.H., Ed., Geotechnical and Environmental Geophysics, vol. 2, 79-88.

Fitterman, D.V., and Hoekstra, P. (1982). Mapping of salt water intrusion with transient electromagnetic methods: Proc. NWWA EPA Conf., Surface and Borehole Geophysical Methods in Ground Water Investigations, Las Vegas, NV.

Fitterman, D.V., and Stewart, M.T. (1986). Transient electromagnetic sounding for groundwater: Geophysics, 51, 995-1005.

Geraghty & Miller. (1985). NACIP Program Confirmation Study, Verification Phase, NAS Memphis.

Goldman, M., Gilhad, D., Ronen, A., and Melloul, A. (1991). Mapping of Seawater Intrusion into the Coastal Aquifer of Israel by the Time Domain Electromagnetic Method. Geoexploration, **28**, 153-174.

Goldman, M., Tabarovsky, L., and Rabinovich, M. (1994). On the influence of 3-D structures in the interpretation of transient electromagnetic sounding data. Geophysics 59, 889-901.

Graham, D.D., and Parks, W.S. (1986). Potential for Leakage Among Principal Aquifers in the Memphis Area, Tennessee. U.S. Geological Survey Water-Resources Investigations Report 85-4295.

Hanson, J.C., Tweeton, D.R., and Friedel, M.J. (1993). A geophysical field experiment for detecting and monitoring conductive fluids: The Leading Edge, 930-937.

Hoekstra, P., and Blohm, M.W. (1990) Case histories of time-domain electromagnetic soundings in environmental geophysics: in Ward, S.H., Ed., Geotechnical and Environmental Geophysics, vol. 2, 1-15.

Hoekstra, P., Lahti, R., Hild, J., Bates, C.R., and Phillips, D. (1992). Case histories of shallow time domain electromagnetics in environmental site assessment: Ground Water Monitoring Review, Fall 1992, 110-117.

Hoekstra, P., Hild, J., and Toth, D. (1992b). Time domain electromagnetic measurements to determine water quality in the Floridan Aquifer. Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems, v.1, 111-127.

Hughes, L.J. (1995). Mapping Chloride Contamination From Salt Cake Fines with Transient Electromagnetics. Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems, Orlando, 792-795.

Inman, J.R. (1975). Resistivity inversion with ridge regression: Geophysics, 40, 798-817.

James, B.A., and Borns, D.J. (1993). Two-dimensional subsurface imaging with transient EM for mapping of a buried dissolution structure near the Waste Isolation Pilot Plant: Proc. of the Symposium on the Application of Geophysics to Engineering and Environmental Problems, v.2, 633-656.

Kingsbury, J.A., and Parks, W.S. (1993). Hydrogeology of the Principal Aquifers and Relation of Faults to Interaquifer Leakage in the Memphis Area, Tennessee. U.S. Geological Survey, Water-Resources Investigations Report 93-4075, 1-18.

McNeill, J.D. (1990). Use of electromagnetic methods for groundwater studies: in Ward, S.H., Ed., Geotechnical and Environmental Geophysics, vol. 1, 191-218.

Mills, T., Hoekstra, P., Blohm, M., and Evans, L. (1988). Time domain electromagnetic soundings for mapping sea water intrusion in Monterey County, CA: Ground Water, 26, 771-782.

Mirecki, J.E., and Parks, W.S. (1994). Leachate Geochemistry at a Municipal Landfill, Memphis, Tennessee. Ground Water, **32**, 390-398.

Munkholm, M.S., and Auken, E. (1996). Electromagnetic Noise Contamination on Transient Electromagnetic Soundings in Culturally Disturbed Environments. Journal of Environmental & Engineering Geophysics, **1**, no. 2, 119-127.

Nabighian, M.N. (1979). Quasi-static transient response of a conducting half-space: an approximate representation: Geophysics, 44, 1700-1705.

Nabighian, M.N., and MacNae, J.C. (1991). Time domain electromagnetic prospecting methods, in Nabighian, M.N., Ed., Electromagnetic Methods in Applied Geophysics, v.2A: Society of Exploration Geophysicists, 427-520.

Newman, G.A., Anderson, W.L., and Hohmann, G.W. (1987). Interpretation of transient electromagnetic soundings over three-dimensional structures for the central loop configuration: Geophysical Journal of the Royal Astronomical Society (Geophysical Journal International), 89, 889-914.

Parks, W.S. (1990). Hydrogeology and Preliminary Assessment of the Potential for Contamination of the Memphis Aquifer in the Memphis Area, Tennessee. U.S. Geological Survey Water-Resources Investigations Report 90-4092, 39p.

Parks, W.S. (1992). Four Levels of Terrace Deposits and Remnants of High-Level Fluvial Deposits in the Hatchie River Valley, Hebron Area, Hardeman County, Tennessee. Mississippi Geology, 13, 63-70.

Parks, W.S., and Carmichael, J.K. (1990). Geology and Groundwater Resources of the Cockfield Formation in Western Tennessee. U.S. Geological Survey Water-Resources Investigations Report 88-4181, 1-17.

Parks, W.S., and Lounsbury, R.W. (1975). Environmental Geology of Memphis, Tennessee: *in* Field Trips in West Tennessee. Tennessee Division of Geology Report Inv. **36**, 35-63.

Parks, W.S., and Mirecki, J.E. (1992). Hydrogeology, Groundwater Quality, and Potential for Water-Supply Contamination Near Shelby County Landfill in Memphis, Tennessee. U.S. Geological Survey Water-Resources Investigations Report 91-4173, 79p.

Sinha, A.K. (1993). Application of two ground electromagnetic systems in environmental investigations (abs.): Proc. of the Symposium on the Application of Geophysics to Engineering and Environmental Problems, v.1, 163-165.

Spies, B.R., and Frischknecht, F.C. (1991). Electromagnetic sounding: in Nabighian, M.N., Ed., Electromagnetic Methods in Applied Geophysics, v.2A: Society of Exploration Geophysicists, 285-425.

Stewart, M.T., and Gay, M. (1981). Evaluation of transient electromagnetics for deep detection of conductive fluids: Ground Water, 24, 351.

Taylor, K., Widmer, M., and Chesley, M. (1992). Use of transient electromagnetics to define local hydrogeology in an arid alluvial environment: Geophysics, 57, 343-352.

Plate G-1 Location Map

This page intentionally left blank.